SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1912.

GENERAL PHYSICS.

122. *Demonstrations of Physical Phenomena.* **O. Lummer** and **E. Waetzmann.** (Phys. Zeitschr. 12. pp. 1135–1139, Dec. 1, 1911.)—A description is given of a model for demonstrating the stream-lines and surfaces of discontinuity produced when a current of air meets with an obstacle. Photographs of the stream-line pictures obtained are given for various cases. Methods of illustrating the increase of hydrostatic pressure downwards, electric waves, the phase-difference of forced vibrations, and curves produced by sound waves, are also described. J. J. S.

123. *Method of determining the Density of Minerals by Means of Rohrbach's Solution having a Standard Refractive Index.* **H. E. Merwin.** (Amer. Journ. Sci. 32. pp. 425–432, Dec., 1911.)—A method, said to be expeditious and accurate, is described of finding the density of a liquid in which grains of mineral are suspended. It depends upon the relation of refractive index to density. The liquid is contained in the small glass cell accompanying the standard refractometers, and its refractive index is determined while the grains are suspended in it. A liquid having as great a range of refractive index as possible for a given difference of density is most advantageous for accuracy; the liquid should also have a wide range of density. Further requirements are: convenience of preparation in a standard condition, and permanency. Rohrbach's solution of barium-mercuric iodide meets these requirements. As usually sold, it has a max. density of about 3·5. To standardise it, it is diluted, at temperature 20°, with water, until the index for sodium light is 1·51 to 1·52. The solution is cleared of precipitated mercuric iodide, a part is left dilute and the remainder concentrated by evaporation. Any crystals in the concentrated part should be dissolved by addition of water. Mixtures of these solutions have a fixed density, correct to 0·001 for a given index. A table is given showing relation of density to index at 20°, and another showing variation of index with temperature at given densities. Before finding the density of grains of a material, the grains should be examined under the microscope in a watch-glass of xylol or alcohol to make sure of freedom from foreign matter. If only the approximate density of a substance is desired, it may be found quickly by matching its density with that of the heavy solution, placing a drop of the solution on the refractometer, covering with a glass slip (to prevent evaporation) and determining the index. A. E.

124. *Strength of Thick Hollow Cylinders under Internal Pressure.* **G. Cook** and **A. Robertson.** (Engineering, 92. pp. 786–789, Dec. 15, 1911.)—Discusses recent work by Carpenter on thick cylinders [see Abstract No. 1078 (1911)] and work on compound stress by Smith and by Mason [Abstracts Nos. 878 and 875 (1910)]. The authors carried out 85 tests. Eight referred to cast-iron and the remainder to carefully annealed mild steel. Hydraulic pressures up to 15 tons per sq. in. were obtained, Petavel's pump (high-pressure) being used. With cast-iron the results obtained confirmed those of previous workers. It is notable that the diagram of material at yield showed that that point coincided exactly with the elastic limit. Figures published show the stress in material at yield as determined by simple tension test, and the internal pressure when yield took place at the interval surface of the cylinder. The experimental values of p/f (when p is bursting stress and f the stress at failure in tension) lie about midway between theoretical values given by Guest's and St. Venant's theories of failure. It was found by extensometer that, owing to eccentricity of loading, the max. stress was 4 or 5 per cent. greater than the mean, and, on that assumption, the experimental curve would be brought nearer the max. shear-stress curve. The difference would still be about 20 per cent., and the results of experiments give the relation of p/f for a thick cylinder as follows: $p = 0{\cdot}6\, f(k^2 - 1)/k^2$, where k is the ratio of external to internal diam. of cylinder. When cast-iron cylinders burst, the failure seems to be determined solely by the max. principal stress and Larne's formula can be applied directly. In the case of mild steel, initial yield takes place when the pressure is about 20 per cent. in excess of that required by the shear-stress theory. The ultimate strength of mild-steel cylinders used in the experiments can be denoted empirically by the same formula as applies to cast-iron. **J. C. Peache, F. van Iterson, G. Cook, A. Robertson.** (Ibid. 93. p. 22, Jan. 5; 58, Jan. 12, and p. 149, Feb. 2, 1912.) C. A. M. S.

125. *Experiments with Aluminium at Low and High Temperatures.* **R. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 2016–2019, Dec. 2, 1911.)—The use of aluminium for steam vessels, &c., induced the author to carry out mechanical tests on annealed, welded, and unwelded bars up to 300° C. In addition, specimens were examined microscopically. The strength decreased steadily with rise of temperature, being at 100° C. 3/4, at 200° C. 2/5, and at 300° C. 1/4 of the strength at 20° C. Cold-worked material is stronger than annealed material at all temperatures. Elongation increased with the temperature, but the regularity of the increase was strongly influenced by the fact that the bars showed a tendency to neck out at several places at higher temperatures. Annealed material shows a greater resistance to shock, but the hardness conferred by mechanical working is not appreciably affected up to 200° C. Heating to 400° C. destroys coarse structure or the elongated structure due to working, but heating to about the fusion temperature confers a coarse structure and lowers the strength and ductility. F. C. A. H. L.

126. *The Magnus Phenomenon.* **A. Lafay.** (Comptes Rendus, 153. pp. 1147–1150, Dec. 4, and pp. 1472–1474, Dec. 26, 1911.)—Magnus found in 1853 that the action produced by a blast directed normally against a cylinder in rapid rotation is an oblique force whose component perpendicular to the current tends to push the cylinder towards the side on which its surface moves with the air-current. The author [see Abstract No. 187 (1911)], who had found that the effect is sometimes reversed, has constructed an Al cylinder capable of rotating 3000 times per min., and 10 cm. in diam. When exposed to a blast of velocity 18 m. per sec., the reversal of the Magnus effect sets in at once. To test the accepted theory of the effect, which supposes it to be due to excess air-pressure on one side of the cylinder, manometric measurements were made by means of a narrow brass probing tube. It was found that on one side there was a slight increase of pressure, but that the Magnus-effect was chiefly due to a high degree of vacuum produced on the side towards which the cylinder was urged. These experiments have a bearing on the deviation of projectiles. E. E. F.

127. *The Displacement of the Particles in a Case of Fluid Motion.* **T. H. Havelock.** (Univ. of Durham Phil. Soc., Proc. 4. 2. pp. 62–74, 1910–1911.)—Mainly a discussion of the paradox that the fluid appears to have a permanent forward displacement ultimately. The difficulty is shown to arise from the introduction of infinities without precise definition of conditions.

L. H. W.

128. *Difficulties which occur in using Exponential Developments.* **A. Léauté.** (Comptes Rendus, 153. pp. 1064–1066, Nov. 27, 1911.)—Solutions of many physical problems can be found in terms of a series of exponential terms. These solutions apply throughout a given interval. But difficulties arise when we try to apply these solutions at the two limits. The author quotes how Dirichlet overcame this difficulty in connection with Cauchy's formula, and shows how this method must be used in the corresponding electrical solutions for the propagation of waves. A. R.

129. *Determination of Ice-drift in Polar Regions.* **O. A. Åkesson.** (Ark. för Mat. Astron. och. Fysik, Stockholm, 6. No. 40. pp. 1–11, 1911.)—When working in Polar regions the method generally employed for the determination of latitude and longitude involves the observation of two altitudes of the sun or other celestial object and the corresponding times. This supposes the observer fixed. If, however, the observer is on a moving ice-field, it is possible to so arrange observations that both the position and velocity and direction of the observer may be calculated. Four observations must be taken of the altitude of the celestial object, and the corresponding times. If the time between the first and second observations, and between the third and fourth be 6 hours, while that between the second and third be several days, the positions are determinable, and from these the velocity and direction of the motion of the ice is easy to compute. C. P. B.

130. *Influence of Anomalous Dispersion on Solar Phenomena.* **P. V. Bevan.** (Roy. Astronom. Soc., M.N. 72. pp. 84–88, Nov., 1811.)—The question is considered as to how far the phenomena of double reversal of the solar spectrum lines may be due to anomalous dispersion effects. If the faculæ are regions where columns of vapour are rising into the sun's atmosphere, these will spread out into extended clouds, producing layers of vapour

at different levels, the higher-level vapours being less dense than those of lower level. This would be sufficient to produce double-reversal phenomena. [See also Abstracts Nos. 910 (1910), 868 (1911).] C. P. B.

131. *Rotation Period of the Sun.* **W. S. Adams** and **J. S. Lasby.** (Papers of the Mt. Wilson Solar Observatory, Vol. I. Part I. 1911. Review by C. P. Butler in Nature, 88. pp. 112–113, Nov. 23, 1911.)—After briefly describing the results of previous observers, five sets of observations are discussed, all by photographic methods, giving the determinations of solar rotation during the periods 1906–7 and 1908. Two sets deal specially with the investigation of the rotation as given by lines in the spectrum of the reversing layer, two others with the red Hα line of hydrogen, and the fifth with the blue line of calcium λ4227. In the general discussion it is shown that the different determinations are in good agreement for latitudes between 0° and 50°. Above 50° the 1908 observations give slightly smaller values, the greatest difference being about 0·089 km. at 70°. The general results do not indicate any variation of the sun's rate of rotation, unless it be of long period. One of the most remarkable results is the fact that lines of different elements give different values of the rotation velocity, lanthanum and cyanogen indicating low velocities, while Mn and Fe indicate relatively high velocities. The adopted formula for representing the Mount Wilson observations is $\xi = 11{\cdot}04^\circ + 3{\cdot}50^\circ \cos\phi$, where ξ is the daily angular velocity and ϕ the solar latitude. C. P. B.

132. *Phase Relations between Planets and Sun-spot Phenomena.* **F. J. M. Stratton.** (Royal Astronom. Soc., M.N. 72. pp. 9–26, Nov., 1911.)—In the endeavour to detect any possible relationships that may exist between the chief planets and the occurrences of sun-spot phenomena, the sun's surface was provisionally divided into 24 lunes of 15° each, the origin being the meridian passing through a given planet at the instant of any observation. These lunes correspond to regions of what may be considered as planet-ruled areas, and the sun-spot phenomena have been tabulated according to their occurrence respecting these arbitrary divisions. Numerous cases showing the results are given, and the general conclusion is that the case for planetary causation of sun-spot formation is not supported by the evidence. The author is of opinion that the dynamical effects of planets upon what may be an atmosphere of uncertain stability should be manifested in some solar phenomena, but sufficient data are not yet available for smoothing out the more direct forces causing the great periodic outbursts. C. P. B.

133. *Spectrum of Comet Brooks* (1911*c*). (Roy. Astronom. Soc., M.N. 72. pp. 30–34, Nov., 1911.)—Photographs of the spectrum of this comet were obtained at the Royal Observatory, Edinburgh, on fourteen days between Sept. 1 and Oct. 31, 1911, with a prismatic camera of 2 in. aperture and 29 in. focal length. The optical system was of quartz and calcite, so that the ultra-violet portions of the spectrum should be recorded as completely as possible. Other spectra were obtained with a larger instrument having an optical train of glass. The exposures ranged from 50 to 201 min. The measured wave-lengths of the spectrum bands recorded are tabulated, showing very close agreement with those found in Comet Morehouse (1908*c*), the chief difference being the presence of a considerable amount of continuous spectrum in Comet Brooks. Two new bands were found in the extreme ultraviolet, the positions of which are λ3351 and λ3057. [See Abstract No. 20 (1912).] C. P. B.

LIGHT.

134. *Turret Mounting for Equatorial Telescope.* **J. Hartness.** (Amer. Soc. Mech. Engin., Journ. 33. pp. 1511–1587, Dec., 1911.)—In the endeavour to obtain a combination of observatory dome and telescope which will allow of the observer working under cover and at any desired temperature, the author has had built a novel form of mounting, which he styles the "turret" mounting. The length of the equatorial is broken at a point nearer the eyepiece than the centre of the focal length, and the portion from the bend to the eyepiece arranged to form the hollow of the declination axis. The chief departure is in the polar axis, which is a cupola running on roller bearings. The advantages claimed are: complete protection to the observer, uniformity of temperature conditions for the telescope, and accessibility to all parts of the visible sky. C. P. B.

135. *Dioptriemeters.* **W. W. Haldane Gee and A. Adamson.** (Manchester Lit. and Phil. Soc., Mem. 55. No. 21. pp. 1–16, 1910–1911.)—The authors have adopted the type of focometer described by Guilloz in 1895 at the Congrês pour l'avancement des Sciences at Bordeaux, but have simplified the instrument so that it can be cheaply constructed. It consists of a wooden upright supported on a wooden base. On the base is fixed a horizontal card marked with a series of concentric circles 1 mm. apart, the radius of the innermost being 5 mm., and that of the outermost 80 mm. A thin disc of metal, with a circular aperture of 10 mm. radius, is supported 100 mm. above the card, and another disc, having a central pin-hole, 200 mm. above the card. The centre of the circular opening is marked by cross-wires, and the centre of the concentric circles by a cross. These two centres and the pin-hole lie in the same vertical line. The lens whose power is to be determined is placed in contact with the disc, and adjusted so that on looking through the pin-hole the centres of the aperture and the circles appear to coincide. The number of circles in the field of view depends upon the power of the lens, and the scale reading of the outermost circle seen gives the power of the lens at once in dioptries (assuming it to be thin). One use of the instrument is to test cylindrical and sphero-cylindrical lenses. The circles appear distorted into elongated curves whose polar equation is of the form $1/r = \cos^2\theta/a + \sin^2\theta/b$. The power of the lens in any meridian can be obtained by observing the scale number of the curve intersecting the boundary of the field of view in that meridian. The dioptriemeter may also be used to localise any irregularity in the curvature of a lens, which will be shown by local distortion of the circles. If a slab of thick glass be placed at an angle to the axis of the instrument, the centre of the rings will be laterally displaced a distance d. If r, i be the angles of refraction, we have $\tan r = \tan i - d/t \cos i$, and $\mu = \sin i/\sin r$, whence μ the index can be calculated. The angle of minimum deviation of a thin prism can be readily found. A plea is entered for the retention of the original spelling, dioptrie, so as to conform to foreign usage. A. E.

136. *The Half-shadow Interferometer as Photometer.* **C. Zakrzewski.** (Acad. Sci. Cracovie, Bull. 8a. pp. 545–547, Oct., 1911.)—Suppose a plane-polarised ray A to be separated into two, a and b, polarised at right

angles, and these to be again united into a single ray B. Then, by measuring the ellipticity of the ray B, both the phase-difference Δ and the amplitude ratio a/b, of the two interfering rays can be determined, and hence the ratio of their intensities. If either a or b, or both, be weakened by the insertion of any body in the path, the values of Δ and a/b will be altered, and therefore, by measuring the alteration, the effect of the inserted substance upon the amplitudes and intensities can be determined, as in the case of an ordinary photometer. If ϕ be the angle between the direction of vibration and that of the final united ray, then $a/b = \tan\phi$, and $d(a/b) = \sec^2\phi \cdot d\phi$. The special advantage of this method is that it is applicable to the ultra-violet as well as to the visible spectrum. A. E.

137. *Spectrograph.* **J. Zenneck.** (Phys. Zeitschr. 12. pp. 1199–1201, Dec. 15, 1911.)—Describes, with diagrams and photographs, a spectrograph the author has had made. The instrument is specially constructed to allow a large amount of light to pass through it; it will easily resolve the Na-lines, is very compact and is reasonable in price. Particulars are given of all the prisms and lenses used. [See also Abstract No. 1020 (1911).] A. W.

138. *New Density Meter.* **W. B. Ferguson.** (Photographic Journ. 51. pp. 405–413, Dec., 1911.)—The invention by Goldberg of a neutral-tinted gelatine-on-glass prismatic wedge opens the way to the construction of inexpensive and handy apparatus for the graduated exposure of plates, and the measurement of densities. The special points claimed for this meter in which such a wedge is employed are (1) one light only is used so that variations in intensity do not affect the measurements; (2) the illumination is from a diffusing plate of glass at a constant distance from the slip to be measured; (3) the plate is measured with the film in contact with a diffusing screen; (4) The densities are read off directly. Its weak point is its inability to measure very minute densities. A. E. G.

139. *Wedge-screens and some of their Uses.* **F. F. Renwick.** (Photographic Journ. 51. pp. 414–422; Discussion, pp. 422–425, Dec., 1911.)—Wedge-screens can now be produced of such accuracy that the errors in them are within the errors of reading a Martens' polarisation photometer. One of the most useful purposes for which they can be employed is the quantitative study of steepness of gradation. The main object of this paper is to show that the development factor can be determined without any form of density-measuring apparatus, by means of a wedge-screen of which neither the density in any part nor the steepness of the gradation is known. A. E. G.

140. *Photography: Neutral-grey Wedges.* **E. Goldberg.** (Zeitschr. wiss. Phot. 10. pp. 238–244, Nov., 1911.)—A continuation of the work previously dealt with [Abstracts Nos. 1125 and 1126 (1911)]. The author describes at length a method of preparing the wedges, which is not difficult and gives good results. A discussion is given of the use which may be made of such wedges in photometry and photography. A. W.

141. *Photographic Impressions upon Copper.* **G. Reboul.** (Comptes Rendus, 153. pp. 1215–1217, Dec. 11, 1911.)—It has long been known that the halogen compounds of copper are sensitive to light. A sensitive plate is produced by placing a highly-polished copper surface in a vessel filled with the vapour of Cl or Br. The sensitivity depends essentially on the thickness of the superficial layer of copper salt so formed: the thinner the layer, the more sensitive it is. The change which light produces upon the salt is not a stable one, for the plate regains its original condition if kept in the dark, this regain being the more rapid the thicker the coating of salt. The activity of the plate also returns with the disappearance of the blackening. This return to the original condition is not due to oxidation, but it seems that the subchloride formed by the action of light takes up fresh chlorine from adjacent layers. This will explain why the sensitivity of the plate depends upon the thickness of the layer of chloride formed. The bromide acts in precisely the same manner. The images can be fixed by means of a very dilute solution of a salt of gold or silver in the presence of hyposulphite. Even then, unless varnished, the images can be easily removed by friction, when a negative appears on the plate. A. E. G.

142. *Selective Radiation of Various Substances.* **W. W. Coblentz.** (Bureau of Standards, Bull. 7. pp. 243–294, May 15, 1911.)—The first part of the paper is devoted to a description of apparatus including the spectrometers, radiometric appliances and rotating sector device; dispersion curves for various prisms of quartz, fluorite, rock-salt and carbon disulphide are also given. The author then proceeds to describe determinations of the emission curve of the acetylene flame under different conditions, including its comparison with incandescent solid substances such as the Nernst glower. He points out the distinction between the action of incandescent small particles and a homogeneous solid radiator, especially as regards absorption effects. Thus an apparent selective action in the deep red is now shown not to be a true emission band, but the result of increased transparency in that region, which persists on into the infra-red. The radiation of acetylene flames is a function of the flame's thickness. Similar researches on the radiation of the Welsbach mantle are next described, and a summary of previous speculations on the subject is given. The author concludes that the source of radiation in the mantle is purely thermal, and he sees no need for the catalytic theory. The nature of radiation of such oxides is, however, affected by a number of circumstances, varying with the temperature and the thickness of the radiating layer. Many such oxides show marked diminution of radiation in the infra-red, aluminium oxide giving practically no energy at all near 8 μ. J. S. D.

143. *Selective Absorption and Emission.* **K. Schaum** and **H. Wüstenfeld.** (Zeitschr. wiss. Phot. 10. pp. 218–237, Nov., 1911.)—From a piece of Pt-foil 0·08 mm. thick a strip was cut about 80 mm. long, 1 mm. broad in the middle, and widened out equally at each end. One side of this was half-coated with the substance under investigation, and the other half was coated with oxide of iron as the comparison substance. The strip could be electrically heated. Both ocular and spectro-photometric methods of investigation were employed. The substances dealt with were Zn, Ur, Th, and Ce oxides, the Auer mantle, Nd and Er oxides, Thénard's blue, Cu, and Au. The results of the research may be summarised thus: Absorption bands are broadened with increase of temperature. The broadening towards the long-wave spectral region is especially noticeable, and is easy to observe in the short-wave region, though occasionally the broadening towards the violet is not decided without difficulty. Absorption lines undergo no displacement with temperature variation. Emission and absorption completely correspond at the same temperature; the colour of the emitted light is therefore complementary to that of the absorbed or reflected light at the same temperature. Bodies with strong selective reflection in the red and yellow (as Cu and Au) show the phenomenon, previously observed by K. Schaum, of the primary green-glow. Numerous substances, which permit of being heated to high temperatures without lasting variation of their spectral effects, show strong variations of their powers of absorption and emission with temperature, and should accordingly be suitable for a quantitative proof of Kirchhoff's law. A. W.

144. *Spectrum of Negative Electrode of Oxygen.* **F. Croze.** (Comptes Rendus, 153. pp. 664–665, Oct. 9, 1911.)—Recently Steubing has given a complete review of all the bands of the negative-electrode oxygen spectrum hitherto known, and has shown that the two bands given by Schuster, 5900–5840 and 6010–5960, are only in reality one and the same band. Steubing's photographs show a group of regular bands, but it is not possible to represent these by the ordinary formula for band spectra. The number of bands is, moreover, too small to enable a regularity to be established with certitude. The author has sought for less refrangible bands which, on account of their feeble intensity, have up to the present escaped observation. A special tube was used, the negative electrode being cylindrical and the light being observed end-on. With this arrangement and a 2-hours' exposure good results were obtained, and a new band was discovered, still less refrangible, like the others, shaded towards the violet, and possessing quite a similar structure. It has two principal maxima, one of which is found 62 Å. from the least refrangible edge of the band, and the other 96 Å. further. In spite of the small dispersion of the spectrograph employed, the definition was sufficiently good to enable 11 components to be separated, which appear themselves to be narrow bands. A table is given of the wave-lengths and approximate relative intensities, the band starting at λ = 6853·6. The first differences of the wave-lengths of the least refrangible lines of each band give numbers which vary considerably, but the decrease of the intervals is the same, the bands thus conforming to the ordinary law. It seems that the five bands can be represented as follows :—

6853	6625	6032		
		5646	5296	4980(?)

which is analogous to the table of the nitrogen bands, the second differences being 85 to 86. A. W.

145. *Green Carbon-band* λ = 5635. **R. Komp.** (Zeitschr. wiss. Phot. 10. pp. 117–134, Oct., 1911.)—Describes very careful re-measurements of the lines of this band from photographs obtained with the large Rowland concave grating at Bonn. The grating is 6·5 m. radius and has 20,000 lines to the inch. A table is given of the results, and the lines are arranged in ten series, which are used to demonstrate the validity of Deslandres' second law. A table giving the position of the heads of the bands compares the results obtained by various investigators. A. W.

146. *Ultra-violet Spark Spectrum of Air.* **F. L. Wagner.** (Zeitschr. wiss. Phot. 10. pp. 69–89, Sept., 1911.)—Photographs were taken of the spectrum obtained by sparking between various metals; the metals employed were Cu, Ag, and Al, and were as pure as possible. The plates were measured by means of Kayser's machine, Fabry and Buisson's normal iron spectrum being taken as the standard. Lines due to impurities were eliminated by the use of tables of the spark spectra of the elements. A table is given of the air wave-lengths from λ4145·84 to λ2369·98, the author's measurements being compared with those of Neovius, Trowbridge and Hutchins, Hartley and Adeney, and Schulemann. Tables are also given of the spark-lines of Cu, from λ4177·78 to λ2104·72, of Ag, from λ4085·88 to λ2065·95, and of Al, from λ3961·74 to λ2269·28. A. W.

147. *Triplet Separations produced by Magnetic Field.* **H. D. Babcock.** (Astrophys. Journ. 34. pp. 288–293, Nov., 1911. Contribution from the Mt. Wilson Solar Observatory, No. 57.)—Recent investigations of the Zeeman-effect for various metals has shown that the separations of the outer components of the triplets may approximately be grouped into two sections. [Abstracts Nos. 1795 (1908), 879 (1911).] The special values for the metals Ca, V, Fe, Ti, Zr, Y, Os, Ba, Th, Mn, Ni, W and Mo are now discussed with regard to this feature. The values of $\Delta\lambda/\lambda^2$ for the triplet lines of each metal were arranged in order of magnitude, and curves are drawn showing the frequencies of their occurrence. A remarkable similarity is presented by all the curves. C. P. B.

148. *Zeeman-effect for Chromium.* **J. E. Purvis.** (Astrophys. Journ. 34. pp. 312–318, Nov., 1911.)—A difference in the separation of the triplets of four Cr lines has been noticed by Babcock [Abstract No. 879 (1911)], and the present paper gives measures on a second plate, showing practically the same result as before, with comparison values given by other investigators on the same four lines. Field strengths up to 39,980 c.g.s. were used. C. P. B.

149. *Zeeman-effect in Lanthanum and Cobalt.* **S. Rybár.** (Phys. Zeitschr. 12. pp. 889–900, Nov. 1, 1911. Extract from Inaug. Dissertation, Budapest.)—Many lines in the spectra of both elements were investigated, the fields used varying from 25,000 to 28,000 gauss. The separations were all reduced to 23,010 gauss, the field strength employed by Runge, as in the measurements by Gmelin [Abstract No. 1044 (1909)]. Results are tabulated, and those for La specially discussed with reference to its place in the periodic system. A. W.

150. *Zeeman-effect for Vanadium.* **H. D. Babcock.** (Astrophys. Journ. 34. pp. 209–224, Oct., 1911.)—Tables are given of the magnetic separations of the vanadium lines between λ3865 and λ6625, reduced to a field strength of 20,000 gauss, the actual fields employed ranging from 17,500 to 19,800. Pieces of pure metallic V, or ferro-vanadium, were used for pole-pieces. The apparatus employed has already been described [Abstracts Nos. 103 (1910), 879 (1911)]. The general type of separation for V is simpler than that for Cr; it has few cases of asymmetry and comparatively few lines of more than four components. There is no evidence of the separation of enhanced lines being different to that of unenhanced lines. C. P. B.

151. *Spark Spectra of Iron and Titanium in Magnetic Field.* **A. S. King.** (Astrophys. Journ. 34. pp. 225–250, Oct., 1911.)—Tables are given showing the character and degree of separation for the Zeeman-effect on the spectrum lines of Fe and Ti. The work is in continuation of that previously noted [Abstracts Nos. 55, 1878 (1901), 2057 (1909)]. The majority of affected lines appear as triplets in the spectra of both elements; a great number of sextuplets are also characteristic. As the work for these two elements is now complete for an extensive range of wave-length, an analysis was made to ascertain the character of the change of separation of the *n*-com-

ponents with wave-length. There appears to be an apparent constancy, the average value of $\Delta\lambda/\lambda^2$ for iron being 2·013, and for Ti 1·858. If this be true in general, it may be said that the mean separation of the *n*-components varies as the square of the wave-length. Possibly a similar law holds for the *p*-components. The former conclusion that the enhanced lines are affected by the magnetic field similarly to non-enhanced lines is confirmed by this later work. None of the lines which are unaffected by the field are enhanced lines. C. P. B.

152. *Recent Progress in Spectroscopic Methods.* **A. A. Michelson.** (Science, 34. pp. 893–902, Dec. 29, 1911. Paper read before the Amer. Assoc. for Advancement of Science. Nature, 88. pp. 362–365, Jan. 11, 1912.) —Traces out the steps by which our present state of knowledge on the subject has been attained, and discusses briefly but clearly the stages in the development of apparatus of high-resolving power, numerical values relating to these latter being given. L. H. W.

153. *Absorption Spectra of Solids and the Quanta Theory.* **F. Haber.** (Deutsch. Phys. Gesell., Verh. 13. 24. pp. 1117–1136, Dec. 30, 1911.)—The emission of electrons takes place when the thermal energy of reaction surpasses the product $h\nu$, where ν is the electronic frequency of the molecule and h is Planck's constant ($6·548 \times 10^{-27}$ erg. sec.). The author interprets h as the work required to deprive an atom or molecule of an electron of frequency 1. The heat involved in any chemical reaction then becomes the product of h into (the sum of electronic frequencies generated − the sum of electronic frequencies destroyed), or $Q = h(\Sigma\nu - \Sigma\nu_1)$. To meet an objection raised by Einstein, the author is led to postulate a relation between the frequency of the atom and its electron. He supposes that in the formula for the undamped proper frequency $\nu^2 = \text{const.}/m\theta$, the laxity ("Verschieblichkeit") is the same for the electron and the positive structure. Then the wave-length will vary as the square root of the mass. Then, if M is the molecular weight of the positive structure, and λ_r and λ_v are the wave-lengths in the infra-red and ultra-violet respectively, we have $\lambda_r = \lambda_v \times 42·81 \sqrt{M}$. This formula is fulfilled by regular crystalline bodies such as NaCl, KCl, and fluorspar.

E. E. F.

154. *Ultra-violet Spark Spectra of Platinum, Iridium, and Rhodium.* **A. Miethe and B. Seegert.** (Zeitschr. wiss. Phot. 10. pp. 245–249, Dec., 1911.)—Describes measurements of wave-lengths of the lines of the spark spectra of Pt, Ir, and Rh in the region 230–190 $\mu\mu$. Tables are given of the results obtained with concave gratings, and comparison is made with the results of Exner and Haschek. A. W.

155. *Spectrum of Nebulium.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 72. pp. 49–64, Nov., 1911)—A series of elements with the simplest possible type of atom are assumed to exist, and one of these, provisionally termed *nebulium*, is considered in detail. The analysis of the theoretical spectrum is found to agree very closely with all the important lines in the actual spectra of nebulæ, thus giving weight to the probability of the recognition of the dynamical system producing the spectrum. This hypothetical atom, when electrically neutral, contains four electrons, each with a charge e, rotating uniformly at equal distances in a circle round a positive nucleus whose charge is $4e$. If one electron is missing, the other three may take up equidistant positions and rotate in a new orbit, the system then consisting of an atom of *nebulium* with a single positive charge. Similarly the atom may

take up more electrons and acquire a negative charge, but must still be regarded as *nebulium* if the positive nucleus remains the same. The subsequent analysis is for the examination of the vibrations perpendicular to the plane containing the electrons in steady motion, as this set appear to be the more important with respect to the visible spectrum. C. P. B.

156. *Spark Spectrum of Indium.* **O. Schulemann.** (Zeitschr. wiss. Phot. 10. pp. 263–280, Dec., 1911.)—Gives a table of wave-lengths of lines in the spark spectrum of indium from λ2265 to λ7455. Many lines not previously observed are given; the character and intensity of the lines are indicated and comparison is made with results of other experimenters. A Rowland concave grating of 3·15 m. radius was used. A. W.

157. *Monochromatic Temperature Radiation of Thallium Vapour.* **G. E. Gibson.** (Phys. Zeitschr. 12. pp. 1145–1148, Dec. 8, 1911.)—A small quantity of thallium was introduced into a quartz tube and purified from oxide by successive distillation into the different sections of the tube, which was previously exhausted. When heated to about 1300° C. the vapour emits the Tl green line strongly, and investigation shows this to be a pure temperature radiation and not a luminescence effect. The tube was heated in an electric oven, and the light from the tube, which had a "black body" behind it, was focussed on the slit of a spectroscope. With the oven at a temperature of 1850° C., a short time after introducing the cold tube into the middle of the oven the reversed Tl line is seen as a dark line on the continuous spectrum of the black body. The line gets weaker as the temperature of the tube, reaches that of the oven, and ultimately disappears. At 1450° C. the phenomena is much more apparent. In about 3 minutes the line disappears completely. If the tube is quickly withdrawn from the oven and the radiation from the latter cut off, the Tl line appears bright on a dark ground for a short time (until the temperature of the tube falls to about 1300° C.). A. W.

158. *Nature of Light emitted by Fireflies.* **P. Singh** and **S. Maulik.** (Nature, 88. p. 111, Nov. 23, 1911.)—A number of fireflies (*Malacodermidæ* fam., genus *Luciola*) were placed over a photographic plate and various materials interposed. The plate was found to be affected through thin layers of wood and leather but not appreciably through glass. Thus the rays given out by the fireflies are in some respects analogous to Röntgen rays and ultra-violet light. E. M.

159. *Distribution of Time-intervals in the Emission of α-Particles from Polonium.* **Mme. P. Curie.** (Le Radium, 8. pp. 354–356, Oct., 1911.)—The present paper is a preliminary account of work on polonium and deals with experiments on the distribution of α-particles according to probability. α-particles from Po were registered both by scintillations and by the electrical method, and the records examined from the point of view of the intervals between successive α-particles. The results show that in a large number, N, intervals the number of magnitude between limits t and $t+\theta$, (θ small), is given by $n_0 e^{-t/r}$, where r is the mean interval and $n_0/\theta = N/r$. The results are thus in agreement with those of Marsden and Barratt [Abstract No. 1848 (1911)]. E. M.

160. *Transformation and Nomenclature of the Radio-active Emanations.* **E. Rutherford** and **H. Geiger.** (Phil. Mag. 22. pp. 621–629, Oct., 1911.)—

A review of recent work on the transformation products in the various radioactive series, chiefly the short-life products after thorium and actinium emanations [see Abstracts Nos. 79 and 1355 (1911) and 168 (1912)]. The series are given as follows :—

Radium Series.			Thorium Series.			Actinium Series.		
Substance.	Period.	Radiation.	Substance.	Period.	Radiation.	Substance.	Period.	Radiation.
Radium Emanation	3·86 days	α-rays [4·23 cm.]	Thorium Emanation	53 seconds	α-rays	Actinium Emanation	3·9 seconds	α-rays [5·7 cm.]
↓			↓			↓		
Radium A	3·0 minutes	α-rays [4·83 cm.]	Thorium A	0·14 second	α-rays	Actinium A	0·002 second	α-rays [6·5 cm.]
↓			↓			↓		
Radium B	26·7 minutes	soft β-rays	Thorium B	10·6 hours	soft β-rays	Actinium B	36 minutes	soft β-rays
↓			↓			↓		
Radium C = $C_1 + C_2$	19·6 minutes 1·38 minutes	α-rays [7·06 cm.] β-rays	Thorium C = $C_1 + C_2$	55 minutes ?	α-rays [5·0 cm.] α-rays [8·6 cm.]	Actinium C	2·15 minutes	[α-rays] [5·4 cm.]
↓			↓			↓		
Radium D		soft β-rays	Thorium D	3·1 minutes	hard β-rays	Actinium D	4·71 minutes	hard β-rays

E. M.

161. *Effect of Red and Infra-red Rays on Decay of Phosphorescence in Zinc Sulphide.* **H. E. Ives** and **M. Luckiesh.** (Astrophys. Journ. 34. pp. 173–196, Oct., 1911.)—From experiments on zinc sulphide, previously illuminated with light freed from red rays by passage through blue glass, it is concluded that phosphorescent zinc sulphide exhibits a flashing-up of luminosity under the influence of long-wave energy, the effect only becoming noticeable after decay of phosphorescence has proceeded for some time, and its occurrence being dependent on the time which has elapsed since excitation. Neither less intense nor shorter excitation hastens the flash-up, but this is reached more rapidly after short exposure to long-wave energy. The intensity of the flash-up is directly proportional to that of the red or infra-red vibrations. There appears to be a direct relation between character of the decay-curve and magnitude of flash-up, specimens whose decay-curve approaches most nearly a straight line, when plotted in terms of $1/\sqrt{(1)}$ against time, showing the effect more strongly than those whose decay plots as a curve. Spectroscopic observations show that the flash-up effect is independent of the wavelength of the exciting light, but occurs the sooner, the shorter the wavelength of the extinguishing light. No change in the spectrum of the phosphorescent light during decay is observed, either before or during the flash-up, indicating that the phenomenon is one of total emission and not of a separate band or part of the radiation. Attempting to explain the effect in accordance with Lenard's theory, the flash-up is ascribed to stored-up electrons, which determine the shape of the decay-curve in the later part of decay, and the quick drop in luminosity in the early part of decay is attributed to unattached electrons, which influence the initial direction of the decay-curve. W. H. St.

162. *Equivalence between Air and Metals for Absorption of α-Particles of Different Velocities.* **W. Michl.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 663–676, May, 1911.)—Taylor has shown that the equivalence as regards stopping power between air and metal-foils alters with the velocity of the α-particles [Abstract No. 1626 (1908)]. In the present paper the results have been verified by a modified method, the number of thin metal-foils (of known thickness) equivalent to 1 cm. of air having been determined for Al, Ag, and Sn. As sources the α-particles from thin films of polonium and ionium were used, these α-particles having different velocities. Thus it was shown that the number of foils equivalent to 1 cm. of air is greater in the case of α-particles of smaller velocity, the effect increasing with the atomic weight. In the experimental arrangement used (ionisation method), the thicknesses of Al and Ag required to cut down the range of the Po α-particles by 1 cm. in air were 5·86 μ and 2·67 μ respectively, while the numbers for ionium were 5·92 μ and 2·75 μ. E. M.

163. *Range of α-Particles from various Radio-active Substances and a Relation between Range and Period of Transformation.* **H. Geiger** and **J. M. Nuttall.** (Phil. Mag. 22. pp. 613–621, Oct., 1911.)—It is well known that the α-particles from different radio-active substances are characterised by their range or the distance through which they travel in air at N.T.P. The present paper deals with a new method of determining these ranges, which is particularly applicable to substances such as Ur and Th, whose activities are small and whose ranges are consequently difficult to determine by the ordinary methods. The inside of a large glass bulb is silvered and connected to a high-potential battery. The active substance is placed in the form of a thin film in the

centre of the bulb on a small disc which is connected to an electrometer. A curve is constructed connecting the ionisation current in the bulb with the pressure of the air contained. The ionisation increases almost linearly with pressure until a certain limit is reached when the α-particles are wholly absorbed before striking the walls of the bulb, further increase in pressure causing no further increase in the ionisation current. This limiting pressure is used to calculate the range at N.T.P. of the particular α-particles, since the distance through which they can pass is inversely proportional to the density of the air. The values obtained are given in tables, the chief being, at 15° C. and normal pressure: Ur, 2·72; Ionium, 3·00; Ra, 3·30; Po, 3·77; Th, 2·72; Radio-Th, 3·87. It is found that if the logarithms of the ranges of the α-particles are plotted against the logarithms of the transformation constants of the products emitting them, the points for the α-ray products of the same family (*e.g.*, the UrRa family) lie on a straight line. From this empirical rule the period of ionium is calculated to be nearly 10^6 years and that of the complex RaC 10^{-6} second. The relation also offers a possible explanation of the reason that no α-ray products of very short range are known. For example, the life of a substance emitting α-rays of 1 cm. range would be so long, and consequently its transformation so slow, that its activity would be beyond the limits of detection by present methods. E. M.

164. *Number of Ions produced by the β- and γ-Rays from Radium C.* **A. S. Eve.** (Phil. Mag. 22. pp. 551–562, Oct., 1911.)—The method employed in the experiments was to place a radium preparation at a known distance from a thin Al-walled electroscope of known capacity and to note the ionisation current produced, the secondary radiations from the walls of the electroscope being almost entirely eliminated, while when required the β-rays were prevented from reaching the electroscope by a magnetic field or by a sheet of absorbing material. It was found that the total number of ions produced in air at atmospheric pressure by the γ-rays from 1 curie of RaC (*i.e.*, the amount in equilibrium with 1 gm. Ra) is $1·1 \times 10^{15}$, while the total number produced by the β-rays is $4·0 \times 10^{14}$. Thus, assuming ionisation to be proportional to energy spent, the heating effect of 1 gm. of Ra giving altogether 110 gm.-cals. per hour is distributed as follows: α-rays, 103·5 cals.; β-rays, 2·0 cals., and γ-rays, 4·5 cals. It is also calculated from the experiments that if there are as many β-particles from RaC as α-particles, then the average number of ions produced per cm. of path of the former is approximately 48. E. M.

165. *Relative Number of Ions produced by the β-Particles from Radio-active Substances.* **H. Geiger** and **A. F. Kovarik.** (Phil. Mag. 22. pp. 604–613, Oct., 1911.)—Consider a β-ray product in equilibrium with an α-ray product. In that case the number of α-particles emitted is identical with the number of atoms breaking up per second of the β-ray substance. By measuring the ionisation due to the β-rays and dividing it by the number of α-particles emitted per sec. from the substance in equilibrium, the ionisation due to the emission of the β-particles from a single disintegrating atom is obtained. The authors have determined these ratios for all substances for which it was possible to carry out such measurements. The number of α-particles was measured either by the scintillation method or by the α-ray ionisation current in a spherical ionisation chamber at low pressure. The β-ray ionisation currents presented some difficulties as several corrections

were necessary, the chief being due to the absorption of soft β-rays by the foils which were necessary to cut off the α-particles, and the reflection of the β-particles by the walls of the various electroscopes employed. The results are given in the form of tables with the various absorption coefficients, &c. The ionisation current for the first cm. of path due to the β-particles per disintegrating atom are found to be as follows: AcC, 6·8 × 10^{-8} e.s. unit (corresponding to 136 ions); ThD, 6·8 × 10^{-8}; RaB, 6·2 × 10^{-8}; RaC 5·0 × 10^{-8}; RaE, 3·2 × 10^{-8}; Ur, 3·6 × 10^{-8}; ThA, 20 × 10^{-8}; Radio-Ac, 0·7 × 10^{-8}; AcA, 0·4 × 10^{-8}; RaD, 0·5 × 10^{-8}. Thus, assuming the ionisation to be independent of the velocity of the β-particles, it appears that AcC, ThC, RaB, and perhaps also RaC, emit two β-particles. On the basis of this assumption the whole number of ions produced by a β-particle of high speed per cm. of its path at atmospheric pressure is 67. [See preceding Abstract.] E. M.

166. *Possible Relation between Uranium and Actinium.* **J. W. Nicholson.** (Nature, 87. p. 515, Oct. 19, 1911.)—It is believed fairly generally that actinium has its source in the disintegration of Ur, although it is not a member of the direct line of descent through Ra. Antonoff has recently shown [Abstract No. 1684 (1911)] that Ur gives rise to UrY which is a branch product and not derived from UrX. The author considers that UrY is produced by the splitting-up of 2 atoms of Ur (weight 477) into 3 atoms of UrY, with atomic weight 159. He also considers UrY to be the parent of actinium, and as evidence in support of this he calculates the atomic weight of AcEm from Russ's experiments to be about 156. E. M.

167. *Thorium and its Disintegration Products.* **M[ay] S. Leslie.** (Le Radium, 8. pp. 356–363, Oct., 1911.)—The paper deals with a chemical investigation of the various radio-active products present in thorite, which the authoress finds contains only about 0·7 per cent. of Ur. The results show no other radio-active constituents than those already known in the Th and Ur disintegration series. The relative equilibrium α-ray activities of the various products is found to be: Th, 5·5 per cent., RaTh, 9·4; ThX, 12·2; ThEm, 48·6; ThB, 12·2; and ThC, 12·2 per cent. The measurements refer to an electroscope with 5 cm. distance between the plates, and point to the conclusion that ThEm gives off 4 α-particles. The experiments also indicate that Radio-Th has a period of a few months only. Further work is in progress. E. M.

168. *Radio-active Products of Short Life.* **H. G. J. Moseley** and **K. Fajans.** (Phil. Mag. 22. pp. 629–638, Oct., 1911.)—The double-screen scintillation experiments of Geiger and Marsden indicated that AcEm apparently gives off two α-particles simultaneously and that ThEm is succeeded by a product of mean life about ⅕ sec. [Abstract No. 79 (1911)]. Geiger later proved the presence of a product of very short life after AcEm, and in the present paper the authors have measured the periods of the two new α-ray products AcA and ThA. [See Abstract No. 1355 (1911) and 160 (1912).] A large disc rotating at very high speed was charged negatively, so that it collected the positively-charged atoms of the products from the respective emanations and rapidly transferred them to ionisation vessels for the measurement of their radiation. The periods were deduced from the loss of activity of the rotating plate during the small interval of time taken to pass from one to the other of two similar ionisation vessels placed near its circumference. The mean values found for the periods were: ThA, 0·14 sec.; AcA, 0·0020 sec. Special experiments also failed to reveal any further complexities in the radiation from actinium active deposit.

E. M.

169. *Time Variation of Activity of Radio-active Substances.* **Mme. P. Curie.** (Le Radium, 8. pp. 353–354, Oct., 1911.)—The paper gives results of experiments on the variation of the activities of Ur, Ra, Ac, and RaD over a period of years. The radiations were measured by compensation by a piezo-electric quartz. The measurements of the α-radiation from Ur were constant to 0·5 per cent. over a period of 4 years. Measurements of the β- (and γ-) radiation from Ra were extended over 20 months, and the activity was found to increase by about 4 per cent., this being probably due to the growth of RaE. Measurements of the β- (and γ-) radiation from an Ac preparation showed a decrease of 10 per cent. in 3 years, pointing to the mean life of Ac, being about 30 years, or to the existence of a product of long life between Ac and radio-actinium. Experiments with RaD extending over a period of 5 years indicated its period to be about 17 years. E. M.

170. *Production of Helium by Radium.* **B. B. Boltwood** and **E. Rutherford.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 313–336, March, 1911. Phil. Mag. 22. pp. 586–604, Oct., 1911.)—The authors have made an extended determination of the volume of He produced from a large quantity of Ra, and found it to correspond to approximately 156 mm. per year per gm. of Ra in equilibrium with its disintegration products to RaC [see Abstract No. 252 (1910)]. This observed rate of production of He is in close agreement with the rate calculated from the counting experiments of Rutherford and Geiger (158 mm.^{3} per year), thus proving that the α-particle during its flight consists of a He atom carrying two unit positive charges and that He itself is monatomic. The authors point out that the agreement of the observed and calculated values is independent of the purity of the Ra-standard employed, as the same standard has been used in both measurements. Determinations of the amount of He produced by the disintegration of a known quantity of RaEm were also made, and found to agree with theory. The production of He by Po and from a preparation containing radio-lead (RaD) was also observed.

E. M.

171. *Intensity of Earth's Penetrating Radiation.* **J. C. McLennan** and **E. N. Macallum.** (Phil. Mag. 22. pp. 639–646, Oct., 1911. Paper read before the Roy. Soc. of Canada, May 16, 1911.)—In the present paper experiments are described in which the ionisation in the air confined in a thin zinc-walled vessel of 30 litres' capacity was measured (1) on the surface of the bare ground, (2) over the ice in Toronto Bay, and (3) at the top of a high clock-tower. The observations support the calculations of Eve on the diminution in intensity of the penetrating γ-radiation from the earth with altitude, and also show that the ionisation over the ground surface is greater than that over the ice by 5·8 ions per cm.^{3} per sec. in the vessel employed. As the penetrating radiation over the ocean from Ra and Th in the sea is negligible, this latter result represents the ionisation produced by the penetrating radiation from the earth and any β-rays which accompany it. Further experiments suggested that at the ground surface the number of ions produced by the β-rays from the earth in the apparatus was 1·5 ions per cm.^{3} per sec. Thus, assuming Eve's value 1·6 ions per cm.^{3} per sec. as the direct

effect of the penetrating radiation, the remaining 2·7 ions per cm.^{3} per sec. must be attributed to secondary radiations from the walls of the zinc receiver. Evidence is given that the results are in good agreement with those of other observers in different parts of the world. E. M.

172. *Optical Properties of Metals.* **C. Zakrzewski.** (Acad. Sci. Cracovie, Bull. 5a. pp. 314–329, May, 1911.)—A continuation from a former paper of the discussion of the optical properties of metals based on Lorentz's theory of metallic conduction. [See Abstract No. 577 (1905).] E. H. B.

173. *Photographic Determination of Right Ascension.* **L. Ambronn.** (Zeitschr. Instrumentenk. 31. pp. 297–305, Oct., 1911.)—Detailed description of a photographic transit instrument for determining fundamental right ascensions, with indexed explanatory engravings. C. P. B.

174. *Wave-length Measurements of Ultra-red Spectrum Lines.* **F. Paschen.** (Ann. d. Physik, 36. 1. pp. 191–197, Oct. 3, 1911.)—Biske has investigated the curvature of the spectrum lines from a plane grating [Abstract No. 1156 (1911)]. This curvature affects the accuracy of the bolometric measurements of ultra-red lines. In the present paper the author discusses the corrections to be applied to his previous accurate determinations of the wave-lengths of certain ultra-red lines [see Abstract No. 73 (1911)]. A. W.

175. *Use of Birefringent Prisms in obtaining Interference Films.* **G. Meslin.** (Comptes Rendus, 153. pp. 1145–1147, Dec. 4, 1911.)

176. *Relation between Selective Photo-effect and Phosphorescence.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 13. 21. pp. 961–966, Nov. 15, 1911.)

177. *Ultra-violet Fluorescence of Benzol and its Derivatives.* **E. Dickson.** (Zeitschr. wiss. Phot. 10. pp. 166–180, Oct., and pp. 181–199, Nov., 1911.)—The original paper should be referred to for the tabulated results. The method of examination employed was in the main that of Stark. L. H. W.

HEAT.

178. *Thermal Conductivity of Some Fats, Earths, and Sands.* **R. Melmer.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 269–281, March, 1911.)—The apparatus used is a modification of Schleiermacher's. The central Pt-wire is replaced by a thin Pt tube (30·6 cm. long, 0·4874 cm. outside diam., and 0·01612 cm. thick) in which a mercury thermometer can be placed to measure the higher temperature, and concentric with this Pt tube is a tube of brass (4·03 cm. diam., 0·108 cm. thick). Between these tubes is placed the material whose conductivity is to be determined, and the Pt tube is heated by an electric current. The brass tube is approximately at the temperature of the room, which is kept as nearly as possible at 20° C. When the thermal conditions are steady, the inner and outer temperatures and the heat equivalent of the electric energy supplied per sec. are noted. These are substituted in an equation deduced for the radial flow of heat in a cylinder and the conductivity is obtained. The end corrections appear to be less than the possible errors of the apparatus. In the experiments four different rates of heat-flow are employed and the arithmetic mean of the results is taken. Thus paraffin wax with a temperature-difference varying from 0·92 deg. to 4·44 deg. (lower temperature about 20° C.) yields a value for the conductivity ranging from 0·0002750 to 0·0002877, the mean of eight determinations being $K = 0{\cdot}0002851$. Under similar conditions yellow beeswax gives $K = 0{\cdot}0002072$ and vaseline $K = 0{\cdot}0002223$. Results for various sands and clays are given and the influence of contained air is noted. The author's apparatus is not suitable for substances which conduct electricity; inherent moisture affects the results considerably. H. S. R.

179. *Thermal Conductivity of Alloys of the Noble Metals.* **F. A. Schulze.** (Phys. Zeitschr. 12. pp. 1028–1031, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe.)—The conductivity for heat of a series of alloys of Pd-Ag, Pd-Au, Pd-Pt, Pt-Au, Pt-Ag, with different proportions of the constituents was determined by a modification of the method of F. Kohlrausch. The values of the constant are given in tables in which the electric conductivity is also stated, as well as the ratio of the two. The result shows that for the five series of alloys the law of Wiedemann and Franz is approximately fulfilled. The deviations occur in the same sense as has hitherto been observed with all alloys which form mixed crystals—as is the case with those here referred to—namely, that the thermal conductivity is not lessened in the same degree as the electric conductivity, so that the quotient of the former by the latter increases to a maximum from the value which holds for the pure metal, with increasing addition of the other metal. This rise is specially great in the case of the Pd-Ag alloys. J. J. S.

180. *Thermal Conductivity of Gases.* **A. Eucken.** (Phys. Zeitschr. 12. pp. 1101–1107, Dec 1, 1911.)—An investigation of the dependence of the thermal conductivity of certain gases on temperature. A modification of Schleiermacher's method was used to determine the thermal conductivity of He, Ar, H, N, O, air and CO_2 for various temperatures ranging from —190° C.

to 100° C. A table is given of the conductivities. As regards the constant K in the formula $k = Kc_v\eta$ (where k = conductivity, c_v = specific heat at constant volume, η = viscosity coefficient) it was found that the values adopted up to the present hold good. For He and Ar K has a value about 2·5; for H, N, O, and air K is about 1·9, while K for CO_2 was found to be about 1·6; all these numbers refer to the temperature 0° C. For the gases He, Ar, N, O, and air the product Kc_v is practically independent of the temperature. The observations on hydrogen point to an increase of c_v with decrease of temperature. For CO_2 the product Kc_v has about the same temperature-coefficient as c_v. In general the observations lead to the conclusion that K is constant for varying temperatures. [See also Abstracts Nos. 585 (1910), 899 (1911), and 186 (1912).] A. W.

181. *Production of Nuclei in Air by Intense Cooling.* **G. Owen.** (Phil. Mag. 22. pp. 563–566, Oct., 1911.)—If dust-free air, dried by standing for three weeks over phosphorus pentoxide, be cooled to a very low temperature, such as that of liquid air, large numbers of small invisible nuclei are produced in the gas. It is difficult, however, to decide with absolute certainty whether these particles are aggregations of *water*-molecules or of *air*-molecules. Owen and Hughes [Abstracts Nos. 1866 (1907), 1450 (1908)] were led to suggest the latter, that is, the *air*-molecule, hypothesis. The result of the experiment here described supports that view. L. H. W.

182. *Melting Heat of Colloids.* **J. Frank.** (Deutsch. Phys. Gesell, Verh. 13. 21. pp. 890–898, Nov. 15, 1911.)—The experiments were made on paraffin wax, beeswax and rosin, mixtures of rosin with turpentine, and mixtures of gelatine and water, the melting being effected (*a*) suddenly, and (2) gradually. In no case was any heat absorption observed (by the temperature-time curves) which could be ascribed to the change from the solid to the liquid state. L. H. W.

183. *Melting-point and Atomic Frequency of Germanium.* **W. Biltz.** (Zeitschr. Anorg. Chem. 72. 3. pp. 313–318, Oct. 19, 1911.)—The atomic frequencies, plotted as periodic functions of the atomic weight, indicate valuable peculiarities of the elements. [See Abstract No. 1601 (1911).] The frequency may be obtained from Lindemann's formula $\nu = 2{\cdot}12 \times 10^{12}(T/mv^{2/3})^{1/2}$, where T is the absolute melting-point, *m* the atomic weight, and *v* the atomic volume. This formula gives a larger proportion of reliable values than the calculation from specific heats. It lends a new interest to the determination of melting-points at present uncertain. The author determines that of germanium, of which he had 1 gm. at his disposal. A portion of this was repeatedly fused and solidified in an atmosphere of nitrogen, the process being watched with a telescope, while the temperature was determined by means of a thermocouple. The fusing began between 911° and 933° C., but a clear reflecting ball was only formed between 948° and 958° C. The fusing-point in hydrogen was 958° ± 5°. A specimen of Ge saturated with its own oxide fuses at 916° ± 5°. The frequency calculated from the melting-point is 8·7 instead of 8·5 as assumed formerly. This pairs it with As, as Sn is paired with Sb, and Pb with Bi. E. E. F.

184. *Thermodynamic Properties of Air and Carbon Dioxide.* **A. G. Worthing.** (Phys. Rev. 33. pp. 217–267, Oct., 1911.)—This paper is partly

theoretical and mathematical, and partly experimental. The ratio of the two specific heats of air and CO_2 was determined at 0°, 31·0°, 50·0°, and 98·5° C., and also for pressures ranging from 8 to 57 atmos. For details the original must be consulted. [*Errata*, ibid. 563, Dec., 1911.] F. J. B.

185. *Theory of Radiation.* **E. Bauer.** (Comptes Rendus, 153. pp. 1466–1469, Dec. 26, 1911.)—Planck's resonators do not really absorb radiant energy, nor do they transform it; they only store it temporarily and diffuse it. Nernst's more concrete hypotheses are a necessary consequence of Planck's, and they are capable of a definite physical interpretation. If the laws of mechanics apply to the encounters between molecules and resonators in a perfectly reflecting enclosure, and the emission of radiation only takes place by quanta, we obtain the law of distribution of energy in the spectrum of the black body but not Einstein's law of specific heats. To obtain the latter we must admit that the exchanges of energy among resonators only take place through the intermediary of the ether. Planck's second hypothesis [Abstract No. 1178 (1911)], which makes only the emission discontinuous, is therefore open to objection. If discontinuities only occur at the moment of shock, while radiation is continuous, Planck's formula and Einstein's law result if the resonators only react when the wave frequency is very near their own. This is not so, as the Doppler-effect produces exchanges between various wave-lengths. The author concludes that all exchanges of energy having a periodic character are effected in a discontinuous manner. E. E. F.

186. *Theory of Heat Conduction in Gases.* **M. v. Smoluchowski.** (Acad. Sci. Cracovie, Bull. July, 1911. Ann. d. Physik, 35. 5. pp. 983–1004, Sept. 1, 1911.)

187. *The Lorentz Contraction for an Ideal Gas.* **A. Weber.** (Deutsch. Phys. Gesell., Verh. 13. 19. pp. 695–699, Oct. 15, 1911.)—Mathematical.

188. *Laws of Energy and Physical Significance of Entropy.* **M. M. Garver.** (Journ. Phys. Chem. 15. pp. 613–638, Oct., 1911.)

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY

189. *Atmospheric Electricity.* XLII. *Observations at Triest, May, 19, 1910. (Halley's Comet).* **E. A. Kielhauser.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a, pp. 1069–1072, July, 1910.)—If the earth passed through the tail of Halley's comet on May 19, the potential might have been raised or lowered by the cometary matter. Brommer's observations in the days May 18 to 25 do not suggest any such influence, however; the variations were not more striking than in the same month of previous years. [Compare Abstract No. 126 (1910).] H. B.

190. *Atmospheric Electricity.* XLIV. *Observations at Seeham in the Summer of* 1910. **E. R. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 1839–1852, Dec., 1910.)—A station has been fitted up at Seeham, 1·5 km. from Mattsee, where regular observations [see Abstract No. 127 (1910)] are being conducted, for special occasional investigations. The paper describes the equipment and preliminary researches concerning arrangements for the registration, the dissipation, and the measurement of the penetrating radiations, *i.e.*, the ionisation due to the radio-activity of the earth's interior and surface and of the atmosphere. H. B.

191. *Atmospheric Electricity.* XLV. *Ionisation in the Danube Valley.* **V. F. Hess** and **G. v. Sensel.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 137–158, Jan., 1911.)—The observations were made on an island in the Danube, 6 km. from Vienna, in Aug. and Sept., 1909; the radium induction measurements [see Abstract No. 1448 (1910)] did not quite coincide with these observations. The valley is very damp, and winds in its direction (NW. to SE.) predominate. The total ionisation has two maxima and two minima in the course of the day, while $q(I_+/I_-)$ and the volume charge $(I_+ - I_-)$ have a maximum in the afternoon and a minimum before sunrise. With strong barometric variations (1 to 3 mm.) the number of ions decreases as the pressure decreases and *vice versâ*; q is smaller with a rising than with a falling barometer. When fog and rain set in, the total ionisation and q are very high; they decrease during rain, when the volume charge becomes negative. The influences of cloud, wind, and clearness of the atmosphere are also studied. H. B.

DISCHARGE AND OSCILLATIONS.

192. *Photoelectric Phenomena in Solid Dielectrics.* **A. Goldmann** and **S. Kalandyk.** (Ann. d. Physik, 36. 3. pp. 589–628, Nov. 9, 1911.)—In sulphur and some other solid dielectrics ultra-violet light produces not only a negative discharge as in metals (Hallwachs) but a true increase in conductivity. In sulphur the conductivity in ultra-violet light is some 1500 times greater than in the dark. When the sulphur is thoroughly dried, the ratio is still 100. The currents obtained are, of course, much smaller than in the case of selenium, but they have the advantage that the current sets in and disappears instantaneously with the illumination, and remains constant during illumination. Sulphur bridges (or "cells") were constructed on Ruhmer's pattern, and currents up to 10^{-10} amp. per cm.^{2} were obtained with 10 volts/mm. There was no potential effect of conductivity, *i.e.*, Ohm's law was found valid. Shellac shows both a surface (Hallwachs) effect and an increase of conductivity. Anthracene, naphthalene, and paraffin also showed photo-electric effects, but much more minute. In all cases there is also a "longitudinal" effect, obtained by illuminating the dielectric through a wire netting, the current being in the direction of the rays. The authors incline to an ionic theory of these effects. **E. E. F.**

193. *Emission of Electrons by Metals under the Influence of α-Rays.* **H. A. Bumstead.** (Amer. Journ. Sci. 32. pp. 403–417, Dec., 1911. Phil. Mag. 22. pp. 907–922, Dec., 1911.)—It has been known for some years that any solid struck by α-rays emits slowly-moving electrons, or secondary δ-rays. If the atoms of solids are ionised by the rays, we would expect that some of the electrons set free in the process from the atoms near the surface would escape from the metal, and that the number escaping would be more or less proportional to the number of atoms ionised. In gases it is known that the ionisation increases rapidly towards the end of the range, and in the present paper it is shown that the number of δ-rays emitted from a thin metal-foil also increases with decreasing velocity of the incident α-rays. A piece of thin metal-foil was enclosed in a vessel at a pressure of 0·0001 mm. Hg and connected to a sensitive electroscope of a modified Wilson pattern. α-particles from Po were directed on to the foil by an arrangement which allowed a variation of their velocity or range by means of absorbing metal-foils. The emission of δ-rays was measured by the charge gained or lost by the metal-foil. The curves connecting the emission of δ-rays with the range of the α-particles were found to be similar in general characteristics to the ionisation curves of Bragg [Abstract No. 2061 (1905)], except that the "knee" was less conspicuous. However, the curves for Au and Al were in close agreement with one another; and in view of the dissimilarity which would be expected from Taylor's results if the effect were assumed to be due to the direct ionisation of the metals, the agreement in the curves obtained leads to the suspicion that the observed effects may not be due to the metals themselves, but, perhaps, to a layer of absorbed gas in both cases. The experiments also give as an estimate that approximately 8 electrons leave both sides of a thin Al-foil for each α-particle passing through it, the foil being placed at a distance equivalent to 2 cm. from the beginning of the range of the α-particles from Po [see Abstract No. 1501 (1911)]. **E. M.**

194. *Canal Rays.* **H. Wilsar.** (Phys. Zeitschr. 12. pp. 1091–1094, Dec. 1, 1911.)—A paper dealing with the origin of the carriers in the displaced and the stationary spectrum lines in the Doppler-effect of canal rays. Three possible explanations of the origin of the carriers are discussed, but the experiments described show that only one of these hypotheses is tenable. The particles shot off from the region of the kathode rush through the whole observation space (behind the kathode) with practically no loss of velocity, they collide with the stationary molecules of the surrounding gas, and are thereby caused to emit light. They are the carriers of the displaced line. In their flight they also render the stationary gas particles of the observation space luminescent, without imparting to them any velocity. These latter particles are the carriers in the stationary line. Further description of experi-

mental work in different gases and vapours, with observations on the Doppler-effect of the canal rays, will be given in a later paper. [See also Abstracts Nos. 905, 1287, 1811 (1910) and 510 (1911).] A. W.

195. *Electrical Reproduction of Celestial Phenomena.* **K. Birkeland.** (Comptes Rendus, 153. pp. 938–941, Nov. 13, 1911.)—Further experiments with the peculiar forms of discharge given by kathode rays from a magnetised globe show very remarkable similarities to various celestial phenomena. Photographs are reproduced in the present paper which very closely resemble the rings of the planet Saturn; others show rays ending in spots, which recall the spots seen on the solar surface, the rays themselves being possibly analagous to the filaments, which have been portrayed in the spectroheliograms of Deslandres. C. P. B.

196. *Particular Case of Interkathodic Action.* **Gouy.** (Comptes Rendus, 153. pp. 1438–1441, Dec. 26, 1911.)—When the two electrodes in a vacuum tube are cylinders whose common axis is in the direction of the magnetic field, the kathode being interior to the anode, E. Bloch [see Abstracts Nos. 124 and 541 (1911)] considers that each electron emitted by the kathode describes a plane spiral curve having for asymptote a circle whose radius R is given by the equation $R - a^2/R = \sqrt{(8mV/e)}/H$, in which a is the radius of the kathode, H the magnetic field, and V the excess of potential of the point considered over that of the kathode. Notwithstanding the experimental analogies, this case remains outside the general view given by the author of interkathodic action, but this is due only to the form attributed to the trajectory of the electron, which in general cannot have for asymptote a circle of radius R. This point is discussed at length in the original. A. E. G.

197. *Effect of Electric Light on Solutions.* **H. Nieuhaus.** (Zeitschr. wiss. Phot. 10. pp. 250–268, Dec., 1911.)—Two methods of investigation were employed. The first of these was similar to the one adopted by Hertz, Wiedemann and Ebert, two spark-gaps being connected in parallel and so arranged that the discharge should take place across the one not in the fluid under investigation when that in the fluid was not influenced by the light from a quartz mercury lamp. The second method was like that used by Kreusler in investigating the effect of electric light on the sparking potential of metals. Numerous solutions were dealt with, and the results show that true solutions are at all potentials unaffected by electric light. A. W.

198. *Characteristics of Discharge between Copper and Iron Electrodes.* **A. Hagenbach.** (Phys. Zeitschr. 12. pp. 1015–1020, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe. Deutsch. Phys. Gesell., Verh. 13. 22. pp. 1047–1057, Nov. 30, 1911.)—A continuation of work already published [see Abstract No. 126 (1911)]. The results previously given are confirmed. In nitrogen a large anode and well-polished electrodes favour the production of the second and third forms of discharge; a small anode and oxidised electrodes that of the first and third. Measurements of the fall of potential throughout the length of the discharge are carried out by means of a carbon probe and confirm the conclusion that the six characteristics are due to three distinct anode-falls and two distinct kathode-falls. The anode-fall is greater for the glow-discharge than the arc. Experiments with iron electrodes give similar results to those with copper. In this case a seventh characteristic may be obtained, due to oxide at the anode. T. P. B.

199. *Condenser Losses at High Frequencies.* **L. W. Austin.** (Washington Acad. Sci., Journ. 1. pp. 143–145, Oct. 4, 1911.)—Experiments were made to determine the equivalent resistance of various types of condensers in high-frequency circuits. Reference is made to Fleming's paper [Abstract No. 884 (1911)]. The method adopted was to measure the current in a spark circuit containing the condenser under test, and then replace the latter by a compressed-air condenser of approximately equal capacity, adding a high-frequency resistance to reduce the current to the same value. Accuracy was obtainable to within 0·05 ohm, and the resistance of the compressed-air condenser was specially determined as 0·25 ohm. Four types of Leyden jar, one paper condenser and a Moscicki condenser were tested, and with 14,500 volts (max.), a current of 7 to 8 amps. and a wave-length of 1000 m. approximately, the following results were obtained:—

	Capacity, mfd.	Added Resistance, ohms.
Leyden Jars, Type 1	0·00603	0·80
„ „ 2	0·00605	0·90
„ „ 3	0·00612	1·30
„ „ 4	0·00603	1·55
Moscicki	0·00548	0·575
Paper Condenser	0·00275	2·05
Standard	0·00575	—

The slight differences in capacity were found to make no observable difference in the results. The paper condenser was measured in parallel with a glass condenser of known loss and its resistance deduced from the result. The same method was used for comparing the compressed-air condenser with different types of Leyden jar immersed in heavy transformer oil. No difference exceeding 0·05 ohm was observed between the jars and the standard, indicating that the losses in the glass are small compared with brushing losses. Three jars immersed in oil were tested at voltages from 4700 to 18,500 (max.). The same circuit was used as above, but it had no spark-gap, and was coupled to a quenched-spark circuit. It is found that the decrement does not perceptibly increase with rising voltage. Comparisons were then made between three jars in air and three in oil, using the added resistance in the circuit excited by a quenched-spark circuit. The difference between air and oil at 4000 volts is almost negligible, amounting in one case to 1·4 ohms at 20,000 volts. The increase was found to be approximately proportional to the square of the voltage as stated also by Fleming. From these results it is clear that brushing is not reduced by placing jars in series, since, if one jar be replaced by four jars in parallel series, the voltage on each jar is reduced to one-half and the loss per jar to one-fourth. The brushing surface is increased four times and the total loss remains the same.

H. H. H.

200. *Electric Waves along Wires.* **J. Wallot.** (Phys. Zeitschr. 12. pp. 994–997, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe. Ann. d. Physik, 36. 4. pp. 681–737, Dec. 7, 1911.)—Describes experiments with electric waves along wires with and without metallic coverings or sleeves. The change of wave-length so produced is attributed to the change in capacity and inductance per unit length. Theory and experiment are in good agreement.

E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

201. *Conduction of Electricity on Surface of Insulators in Moist Air.* **E. Schrödinger.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 1215–1222, July, 1910.)—The method adopted is to charge up an electroscope from a battery through a rod of the material, suitable arrangements being made to obtain the required degree of humidity in the surrounding air. The rate of charging-up of the electroscope of known capacity gives the current, and from this and the e.m.f. of the battery the resistance of the material surface is calculated. The results show that the resistance in moist air of the following materials is in increasing order: Glass, ebonite, amber, sulphur, and paraffin. A. E. G.

202. *Variations of the Conductivity of a Phosphorescent Body under the Action of Light.* **P. Vaillant.** (Comptes Rendus, 153. pp. 1141–1144, Dec. 4, 1911.)—The body studied was calcium sulphide. The CaS was fixed in a ½-mm. slit made in leaves of tin glued on a sheet of glass. The whole was placed in a black chamber, and light from an incandescent lamp was arranged to fall on the CaS through 10 cm. of water and through a slit in the wall of the chamber. The increase of conductivity caused by the radiant energy is not instantaneous. In the variations produced there are three periods: (1) The period of illumination during which the conductivity increases at first somewhat slowly, then more quickly and almost linearly, then again less quickly, finally passing through a maximum and then diminishing slowly. (2) A period during which the conductivity increases although the illumination has ceased. On cessation of the illumination the conductivity always commences by increasing, and reaches a maximum which is attained more quickly and abruptly the more prolonged has been the period of illumination. (3) The period of decrease of conductivity in which there is first a quick falling-off, lasting only a few minutes, then a much longer period of regular decrease, during which the conductivity diminishes proportionally to the time for relatively short illuminations, or proportionally to the square of the time if the illumination has been very prolonged, the time being counted from the commencement of the illumination. There is then a period of slow and irregular increase of resistance which seems to be unconnected with the illumination.
J. J. S.

203. *Resistivity and Thermo-electricity of Tantalum.* **H. Pécheux.** (Comptes Rendus, 153. pp. 1140–1141, Dec. 4, 1911.)—Different specimens of Ta from the same source show considerable differences in resistivity. (1) *Resistivity.*—The following results were obtained for the resistivity in microhms of three samples of Ta taken at random, obtained from Siemens and Halske, of Berlin:—

A. $Pt = 14\,(1 + 0{\cdot}0029t - 0{\cdot}0000019t^2)$;
B. $Pt = 15{\cdot}12(1 + 0{\cdot}0022t + 0{\cdot}0000091t^2)$;
C. $Pt = 16{\cdot}88(1 + 0{\cdot}0025t + 0{\cdot}0000004t^2)$.

On oxidising each wire by treatment with pure boiling potassium the presence of Nb in small but appreciable quantity was detected. The arrangement of the samples in decreasing order as to quantity of Nb is A, B, C. The results show that both the resistivity and the principal temperature-coefficient increase with the purity of the metal. (2) *Thermo-electricity.*—A thermoelectric couple was made with each of the wires and a wire of pure Pt, and the e.m.f. determined between 0° and 400°. Each Ta wire was well annealed. The following values were deduced for the thermoelectric power in microvolts of the three couples at t° C. :—

$$\begin{aligned} &\text{A.}\quad dE/dt = 0{\cdot}26 + 0{\cdot}0048t\,; \\ &\text{B.}\quad dE/dt = 1{\cdot}28 + 0{\cdot}0068t\,; \\ &\text{C.}\quad dE/dt = 2{\cdot}20 + 0{\cdot}0246t. \end{aligned}$$

Thus the thermoelectric power increases with the purity of the Ta ; annealing increases it. The specimen C was the purest ; it contained traces of carbon. In the thermoelectric scale the metals A and B come between Pt and Pd ; the metal C, which is almost pure Ta, between Pb and Pt + 10 per cent. of Rh.

J. J. S.

204. *Dielectric Constants of Certain Liquids at High Pressures.* **R. Ortvay.** (Ann. d. Physik, 36. 1. pp. 1–24, Oct. 3, 1911.)—The dielectric constant of certain liquids was measured by means of a form of Nernst's apparatus, at varying pressures. The pressures ranged from 0 to 500 kg./cm.². It is found that, for the liquids investigated, viz., ether, benzene, toluene, xylene, carbon disulphide, chloroform, liquid paraffin, petroleum ether, and castor oil, the dielectric constant increases with the pressure, but that the increment diminishes with increasing pressure, in such a way that the dielectric constant can be expressed by the graduated formula $D_p = D_1(1 + \alpha p + \beta p^2)$, where α is positive and β negative. For the chemically related substances benzene, xylene, toluene, the change of the dielectric constant takes place in a similar manner. The constancy of the Clausius-Mossotti expression was only tested on ether and benzene, and with both liquids it decreases with the pressure : ether by 1·3 per cent. and benzene by 1·17 per cent. of the original value. The Clausius-Mossotti expression is not only not constant, but depends upon the temperature as well as the specific volume. F. J. B.

205. *The Attraction of Two Coaxial Circular Currents.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 10. pp. 152-158, Nov., 1911.)—The author, taking the simple q series he had previously found for the mutual inductance between two coaxial parallel circular currents, differentiates it and shows how the result can be expressed in various simple forms. He shows that Rayleigh's calculations can be verified by his method, and computes a table by means of which the attraction can be readily calculated in most cases with a maximum inaccuracy of less than 1 in 1,000,000. A. R.

206. *A Bismuth-Silver Thermopile.* **W. W. Coblentz.** (Frank. Inst., Journ. 172. pp. 559–567, Dec., 1911.)—The method of construction of a Bi-Ag thermopile is described. Fine wires were used, and the length of the receiving surface of the pile, consisting of 20 junctions, was 12 mm. The thermoelectric power of this Bi-Ag thermo-couple is 89 microvolts per degree, as compared with an iron-constantan couple which is 51 to 53 microvolts per degree. The *temperature* sensitivity of Bi-Ag is therefore about 74 per cent. greater than an iron-constantan thermopile. Whether the *radiation* sensitivity is increased in like proportion depends upon the selection of the proper diameters of wires, but a radiation sensitivity 2 to 3 times that of the iron-constantan pile was obtained. Besides this linear pile details are given of the construction of a thermopile having a large receiving surface built up of single units, each of which contains 20 or more thermo-elements, mounted upon an ivory support. J. J. S.

207. *Electric Resonator.* **J. B. Kremer.** (Elect. Rev. and West. Electn. 59. pp. 1203–1204, Dec. 9, 1911.)—A description of apparatus designed for obtaining and exhibiting the powerful resonance effects which are observed in an earthed helix when it is in resonance with a condenser circuit. The primary inductance is a flat spiral, and on this the resonating helix stands, a plate of glass insulating the one from the other. T. P. B.

208. *Balance for Measurement of Changes in the Earth's Vertical Magnetic Field.* **K. Schering.** (Phys. Zeitschr. 12. pp. 1047–1048, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe.)—The author describes a magnetic balance for the photographic registration of changes in the vertical component of the earth's magnetic field, which is similar to Kohlrausch's four-bar magnetometer for measurement of differences in horizontal intensities at different places. In this balance there is attached, in the geometrical prolongation of the horizontal agate knife-edge of the beam of the balance, an axle round which a cross-shaped frame with four magnets can be rotated. These four magnets lie in the same vertical plane, are parallel to one another, and are arranged as in the Kohlrausch magnetometer. The magnet frame, however, here serves a double purpose, as it also renders the apparatus free from temperature effects and of given fixed sensitiveness. The paper describes how the apparatus is best adjusted to this condition.

A. D. R.

ALTERNATING CURRENTS AND MAGNETISM.

209. *Magnetic Manganese Arsenide and Iron Arsenide.* **S. Hilpert** and **T. Dieckmann.** (Ber. Deut. Chem. Gesell. 44. pp. 2378–2385, 1911.)—The authors find that the best method for preparing pure arsenides of the metals is to heat them at a high temperature with the vapour of As under pressure. The finely-powered metal and the As are sealed up in an evacuated bomb-tube of Jena glass, and heated for several hours at 700–750°. After cooling, the almost chemically pure arsenide can be mechanically separated from the As which has condensed on the walls of the tube. Manganese arsenide (MnAs) could only be obtained in the pure condition when Mn prepared from the amalgam was used. Aluminothermic Mn did not give satisfactory results. The arsenide is a greyish-black powder showing apparently no crystalline structure; D = 6·2. When heated in a current of hydrogen, As is gradually volatilised, but no other compound is formed. It is strongly magnetic, but loses its magnetic properties when heated at 40–50°, the effect being a reversible one. As regards the compound Mn_3As, no evidence has been found that it exists. The arsenides of iron ($FeAs_2$ and FeAs) were also prepared. Both of these are completely non-magnetic. T. S. P.

210. *Further Ferro-magnetic Compounds of Manganese.* **E. Wedekind** and **T. Veit** (with **K. Fetzer**). (Ber. Deut. Chem. Gesell. 44. pp. 2668–2670, 1911.)—Manganese bismuthide (MnBi) was obtained by the interaction of manganese thermite and bismuth. It forms octahedral and eight-sided columnar crystals, which are strongly magnetic. The same compound was also obtained, but with difficulty, by the direct fusion of the components in an atmosphere of hydrogen. Manganese selenide (MnSe) was formed by heating manganese and selenium in an evacuated bomb-tube. It is crystalline in structure, weakly magnetic, and readily decomposed by water and mineral acids. The telluride (MnTe) was prepared in a similar way, and has similar properties; it is crystalline, and has a silvery lustre. Manganese silicide (Mn_2Si) was obtained from manganese thermite and Si as a crystalline, greyish-black powder, which has hardly any magnetic properties. The sulphide (MnS) was also prepared by the aluminothermic method; it is weakly magnetic, the magnetic properties becoming more pronounced on heating. Manganese arsenide was obtained by heating Mn and As together. The resulting regulus was freed from Mn with dilute hydrochloric acid, and from excess of As by heating in chlorine or bromine. A black crystalline powder was left, which, on analysis, gave figures approximating to those calculated for MnAs. It was not pure, however, and on further heating in an electric oven, arsenic was lost and the compound Mn_2As formed [compare Hilpert and Dieckmann, preceding Abstract]. It is distinctly magnetic, in contradistinction to the arsenide first formed. Manganese carbide cannot be prepared by the aluminothermic method. The compound, Mn_3C, obtained in the electric furnace, is magnetic. The compounds of manganese with tervalent elements are the most strongly magnetic. [See Abstract No. 1529 (1910).] T. S. P.

211. *Ferromagnetic Compounds of Manganese with Phosphorus, Arsenic, Antimony, and Bismuth.* **S. Hilpert** and **T. Dieckmann.** (Ber. Deut. Chem. Gesell. 44. pp. 2831–2835, 1911.)—Manganese phosphide (MnP) was prepared from manganese and phosphorus in a manner similar to that used for the arsenide [see Abstract No. 209 (1912)]. It forms an inodorous, black powder, which burns on heating in the air, giving magnetic, black oxidation products. Manganese antimonide (MnSb) was obtained by heating a Mn amalgam, prepared by electrolysis, with the requisite amount of Sb in an atmosphere of hydrogen, the mercury being finally distilled off. It is a grey substance, which burns in the air, giving non-magnetic products. Manganese bismuthide (MnBi) was prepared similarly to the antimonide, and has similar chemical properties; it is silver-white in colour. The following are the temperatures at which the magnetic properties of these compounds are lost and regained, the first temperature denoting loss of magnetic properties on heating, and the second, gain of the same on cooling; they indicate that hysteresis occurs: MnP, 18–26°; MnAs, 40–45°; MnSb, 320–330°; MnBi, 360–380°. The higher the atomic weight of the element combined with Mn, the higher is the temperature at which the magnetic properties are lost. T. S. P.

212. *Magnetisation of Cobalt.* **W. W. Stifler.** (Phys. Rev. 33. pp. 268–294, Oct., 1911.)—A careful determination of the magnetisation of cobalt as a function of the temperature up to 1150° C. was made. From these results the value of the intrinsic molecular field of Co and the moment of its elementary magnet were deduced. The experimental method employed was the method due to Weiss. It consisted in observing the throw of a ballistic galvanometer connected in series with a helix placed in a strong longitudinal magnetic field when an ellipsoid of the substance to be tested is suddenly jerked out of the helix; the ellipsoid of Co was ground out of a bar of the metal and heated to the desired temperature in an electric heater placed between the poles of the electromagnets. The chief results obtained were: (1) The saturation value of the intensity of magnetisation of cobalt was determined at intervals of 100 to 150 degrees throughout the interval from 22° to 1150° C.

(2) The "Curie Point," or point of magnetic transformation from the ferromagnetic to the paramagnetic state, has been established at 1075° C. (3) The curve giving σ as a temperature function is found to have the same general character as that demanded by theory, but differs from the theoretical curve by a constant amount throughout most of its length. (4) The values of the intrinsic molecular field H_m, the moment (M) of the elementary magnet, the number of atoms (n) in an elementary magnet, and the elementary charge e, have been calculated and found to have the following values: $H_m = 8{,}870{,}000$; $M = 6{\cdot}21 \times 10^{-20}$; $n = 4$; $e = 4{\cdot}65 \times 10^{-10}$ e.s. unit. F. J. B.

213. *Magnetism of Copper and its Oxides.* **F. Behnsen.** (Phys. Zeitschr. 12. pp. 1157–1160, Dec. 8, 1911.)—The author discusses the anomalous residual magnetism found in some quenched specimens of nearly pure copper by Gray and Ross [see Abstract No. 588 (1909)], which was attributed to the peculiar action of a very slight trace of impurity. The author has conducted a series of experiments on the magnetism of copper and its oxides with the following results:—Pure electrolytic copper and pure cupric and cuprous oxides show no residual magnetism. Ordinary cupric oxide is magnetic, and when reduced in a current of hydrogen gives copper which is more permanently magnetic than the cupric oxide itself. Pure electrolytic copper is diamagnetic, and remains so after all thermal treatment, but pure cupric and cuprous oxides are paramagnetic. Copper obtained by reduction from ordinary copper oxide is more strongly paramagnetic than the oxide itself. It is suggested that the residual magnetism found by Gray and Ross in certain copper specimens might be due to a trace of iron present as iron oxide along with the copper oxide, and through reduction the more magnetic metallic iron was produced. A. D. R.

214. *Kerr's Electro-optic Effect in Vapours and Gases.* **E. Giurgea.** (Comptes Rendus, 153. pp. 1461–1464, Dec. 26, 1911.)—According to Lippmann's theory there ought to be a contraction of a gas subjected to the action of an electric field according to the relation $dv/v = (K-1)E^2/8\pi pe^2$, that is to say, proportional to the square of the field intensity and increasing with increase of the dielectric constant K. The author has sought to observe this by a differential method. A pair of metal tubes 0·5 to 3 m. long, closed at the ends by strong windows of parallel glass, contain the gas, and an arrangement enclosed in one tube allows of the gas being subjected to a strong electric field. A beam of light from an electric arc is rendered parallel by a collimating lens, falls on a Jamin mirror, and the resultant twin beams each traverse one of the tubes. Afterwards they are re-combined, and if the application of the electric field causes a contraction of the gas with a corresponding increase of density, the change is measured by the displacement of the interference fringes due to the relative retardation. With air and CO_2 under pressures up to 25 atmos. no effect was observed. Vapours of C_2H_5Br, CS_2, and CCl_4, all of which have high dielectric constants, were also tested at pressures of 2 to 3 atmos., this pressure being used to increase the electrostatic rigidity, and so permit the employment of intense electric fields without sparking. A slight change in the bands was observed indicating a retardation of the light in the gas subjected to the stress. The amount was slightly greater than that given by Lippmann's formula. The author considers that the phenomenon is also present in gases, but is too small to be detected with the apparatus used. The work is to be continued with more delicate apparatus. A. D. R.

RADIOLOGY AND ELECTROPHYSIOLOGY.

215. *Estimation of Röntgen-Ray Doses.* **Regaud** and **T. Nogier.** (Archives d'El. Médicale, 19. pp. 458–460, Nov. 25, 1911. Paper read before the Assoc. franç. pour l'avancement des Sciences, Aug., 1911.)—It is argued that the comparison of the tint of the barium platinocyanide which is used in the estimation of doses of Röntgen rays should be made by means of artificial light, and daylight comparisons should be avoided. A table is given at the end in which are compared the tints as seen with (*a*) blue sky, (*b*) cloudy sky, (*c*) diffuse light, and (*d*) at 15 c.m. from a Nernst lamp. A. E. G.

216. *Elastic Waves in Æolotropic Media.* **M. P. Rudzki.** (Acad. Sci. Cracovie, Bull. 8a. pp. 508–536, Oct., 1911.)—Highly analytical memoir. [See Abstract No. 996 (1900).] E. H. B.

217. *Temperature Coefficient of Resistance of Copper.* **J. H. Dellinger.** (Bureau of Standards, Bull. 7. pp. 71–101, Feb., 1911.)—The full paper corresponding to Abstract No. 250B (1911).

218. *Electrical Conductivity of Commercial Copper.* **F. A. Wolff** and **J. H. Dellinger.** (Bureau of Standards, Bull. 7. pp. 103–130, Feb., 1911.)—The full paper corresponding to Abstract No. 249B (1911).

219. *The Work of the Electrical Division of the Bureau of Standards.* **E. B. Rosa.** (Science, 34. pp. 8–19, Jan. 5, 1912. Paper read before the Amer. Assoc. for Advancement of Science.)

220. *Peltier Effect and Production of "Cold."* **E. Altenkirch.** (Phys. Zeitschr. 12. pp. 920–924, Nov. 1, 1911.)—A theoretical paper, which cannot be abstracted. T. P. B.

221. *Thermo elements for Experiments with High-frequency Currents.* **L. W. Austin.** (Phys. Zeitschr. 12. pp. 1226–1227, Dec. 15, 1911. From the English.)—Constructional details of a Te-Pt couple. L. H. W.

222. *Ratios of the Magnetic Moments of Molecules, and the Magneton.* **P. Weiss.** (Phys. Zeitschr. 12. pp. 935–952; Discussion, p. 952, Nov. 15, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe.)—A collected summary of the results already published. [See Abstracts Nos. 528, 529, 677, 791 (1911).]

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

223. *Metallic Cerium.* **A. Hirsch.** (Amer. Electrochem. Soc., Trans. 20. pp. 57–102; Discussion, pp. 102–104, 1911. Metallurgical and Chem. Engin. 9. pp. 540–544, Oct., 1911.)—The author communicates the results of three years' researches, conducted at the University of Wisconsin with the object of studying pure cerium and of finding applications for the rare-earth residues from monazite sand obtained in the gas-mantle industry. The calcined oxalates gave about 97 per cent. of oxide, half of which was CeO_2. The author had several kg. of materials at his disposal. The rare-earth chlorides are difficult to dry because they decompose like $MgCl_2$; when oxides are converted into carbides (in arc furnace) and treated with alcoholic HCl, the solution contains graphite. The best way is to start from the cerium-ammonium nitrate and to evaporate this many times with concentrated HCl. The CeF_3 can be obtained from the chloride by precipitating with HF and washing with alcohol. The reduction of the oxides by means of Mg, Ca, Al, C, Si yields alloys, carbides, or silicides, or lower oxides; Al-thermite failed; the alloys and carbides are pyrophoric. The electrolytic reduction of fused fluoride, which readily dissolves the oxides and thereby becomes a better conductor, is very difficult on account of the formation of carbides in the carbon vessels; all other vessels are attacked by the fluoride. The anhydrous cerous chloride or chloride mixture can be electrolysed in a wrought-iron pipe bolted to an iron flange and bottom plate; some NaCl, KF, and $BaCl_2$ are added, and currents of 200 amps. at 15 volts are used. The deposited cerium contains iron, carbide, and oxide, and is purified by preparing cerium amalgam, from which a metal of 98 per cent. of Ce was obtained. The metal is malleable and ductile and weakly paramagnetic; the thermal conductivity seems to be high, the electric conductivity low (which would be exceptional); the calculated single potential $Ce/CeCl_3$ in normal solution is —3·16 volts against the calomel electrode. The paper describes the mechanical, physical, and chemical properties of cerium, and the alloys formed with many metals. Most of the alloys are high-grade, containing about 70 per cent. of Ce, brittle and pyrophoric; they make good reducing agents. H. B.

224. *Chemical Affinity and Electronic Frequency.* **F. A. Lindemann.** (Deutsch. Phys. Gesell., Verh. 13. 24. pp. 1107–1116, Dec. 30, 1911.)—Haber's conclusion [see Abstract No. 153 (1912)], that the heat of chemical combination per molecule is of the same order of magnitude as the algebraic sum of the energy quanta corresponding to the selective photo-effects of the elements and the proper frequencies of compounds, may be obtained without having recourse to Planck's action quantum h. The electronic frequencies of the selective photo-effect may be calculated from the formula $2\pi\nu = \surd(ne^2/mr^3)$, where n is the valency and r the distance between the centres of two contiguous atoms. Resonances should then be found for each of the several valencies of an element, and are actually so found in Al and in Lenard's phosphores. This formula may be combined with Haber's relation $\nu_r = \nu_v \surd(m/M)$ so as to test the latter. The new formula is $2\pi\nu = e\surd(n/Mr^3)$, and this again may be combined with Einstein's compressibility formula. The resulting relation is $\nu = \text{const.} \times r^4/ne^2$. This means that in the normal atomic distance the force holding the atoms in position varies inversely as the cube of the distance. There is a fair agreement between the calculated and observed compressibility. E. E. F.

225. *Measurement of Chemical Affinity.* **J. Koenigsberger.** (Phys. Zeitschr. 12. pp. 1084–1090, Dec. 1, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe.)—The author distinguishes two kinds of affinity between electron and atom: (1) an external affinity, due to electrostatic action at considerable distances; (2) an internal affinity, due to electro-chemical forces within the atom, and localised at special places of the atom. Examples of the former are the effects discovered by Lenard, Wehnelt, and Richardson, and the photoelectric effect in solids. The latter is exemplified in most voltaic phenomena. The author shows how these affinities can be measured by observations of conductivities and canal rays. By determining the relation between resistance and temperature between -190° C. and $+1000^\circ$ C. [Abstracts Nos. 849 (1910) and 1724 (1911)], it is possible to calculate the heat of dissociation Q in gm.-cals. between 1 gm.-atom of negative electrons and 1 gm.-atom or -mol. of positive ions. The only other phenomenon which gives an indication of a change in the number of free electrons is the Hall-effect. The result of the above measurement is a first approximation to the internal affinity of the strongest valency of the atom. If the substance occurs in irreversible allotropic forms, Q may show very varying values. Thus, in graphite, Q is 400 to 800, while in diamond it is 10,000. As regards canal rays, the author, in conjunction with Kutschewski, found that the blackening of a photographic plate by canal rays does not vary with the charge of the latter, but only with their number [see Abstract No. 540 (1911)]. He concludes that in the canal-ray particle the addition of an electron is only due to external electrostatic forces, and not to internal affinity. The same applies to the emission of an electron by a neutral particle. The electron is evidently bound in two different ways—in the canal-ray particle and in the oxygen or helium atom in the solid state, respectively. But the author found that a negative canal-ray particle, such as is sometimes produced in the presence of water-vapour, is, when subsequently neutralised, identical with a neutralised positive ion. A negative canal-ray ion is generated, in fact, by the addition of two electrons to the positive ion. The first electron is attracted by the external, and the second by the internal affinity. E. E. F.

226. *Heat of Formation of Titanium Dioxide.* **W. G. Mixter.** (Amer. Journ. Sci. 33. pp. 45–48, Jan., 1912.)—In 1909 the author determined the heat of formation by the sodium-peroxide method, and found the value 215,600 cals. [see Abstract No. 1129 (1909)]. By burning Ti in oxygen, Weiss and Kaiser obtained only 97,772 cals. [Abstract No. 1527 (1910)]. In repeating his experiments with oxygen, the author separates the titanium particles as much as possible. He places cotton-wool in a silver bomb of 100 c.cm. capacity and scatters titanium grains (1 mm.) or powder over the cotton, which is ignited by a cotton thread suspended from a fine Pt-wire connecting the electrodes in the bomb. The metal melts to a globule of crystalline oxide, white outside, dark inside, which is hollow, indicating a slight dissociation of the oxide formed during cooling. The powder gave smaller values than the grains, and it resulted that the powder contained about 8 per cent. of oxygen; subsequent experiments established that there is superficial oxidation of pure Ti to this extent when it is powdered. The heat of formation $Ti + O_2 = TiO_2$ is $+218,400$ cals. H. B.

227. *Absorption of Hydrogen by Palladium at Small Pressures and Low Temperatures.* **S. Valentiner.** (Deutsch. Phys. Gesell., Verh. 13. 22. pp. 1003–1022, Nov. 30, 1911.)—Describes research on the absorbing power of Pd at various temperatures ranging from 20° C. to —190° C., and for hydrogen pressures below 5 mm. Curves are plotted from the results, showing how the absorption increases with the pressure. The observations at low temperatures show a remarkably strong absorption. The hydrogen pressure giving an absorption of 1 mgm. of hydrogen in 1 gm. Pd is at —78° C. 0·25 mm., while at —190° it is only 0·001 mm. The results are discussed. Further work on the subject appears desirable. [See also Abstract No. 658 (1911).] A. W.

228. *Solubility of Gases in Metals.* **A. Sieverts** and **W. Krumbhaar.** (Ber. Deut. Chem. Gesell. 43. pp. 893–900, 1910.)—The volume of the gas absorbed by a number of metals and alloys when heated to various temperatures was determined both when the metal was in the liquid and solid state, and under varying conditions of pressure. For temperatures up to 1100° C. a quartz flask was used, being heated by a Pt-resistance furnace; for temperatures up to 1800° C. a glazed porcelain tube heated in an Heræus furnace, and for higher temperatures a specially-designed furnace was employed in which a biscuit porcelain tube containing the metal was placed, and which withstood a temperature of 1650° C. at the ordinary pressure, 1550° at 500 mm. and up to 1400° when evacuated, without collapsing. It was found that nitrogen was not soluble in Cd at 400° C., in Tl, Zn, Pb, and Cl at 600° C., in Sn and Sb at 800° C., in silver and gold at 1800° C., and in Cu, Ni, and Pd at 1400° C. Aluminium reacted at about 800° C., and iron absorbed nitrogen at 1200° C., which gas was not evolved again in a vacuum, showing the probable formation of a nitride. Neither solution nor chemical reaction took place between copper and CO at 1520° C., but both solid and liquid Ni absorbed CO which was not evolved again in a vacuum. Sheet cobalt evolved large quantities of gas at 1400° C., but this was not analysed. Liquid silver dissolved oxygen, while gold did not. Experiments were carried out on the system copper-sulphur dioxide in relation to the solubility under varying pressures and temperatures. Liquid copper when solidifying retained 80 per cent. of the SO_2 absorbed, and which was all evolved in a vacuum. Hydrogen was not absorbed by the metals cadmium, thallium, zinc, lead, bismuth, tin, antimony, silver, and gold. The solubility in copper, nickel, iron, and palladium is very different, and is shown in a table and graphic curve diagram in the original. L. H. W.

229. *Absorption of Gas by a Porous Body.* **J. Duclaux.** (Comptes Rendus, 153. pp. 1217–1219, Dec. 11, 1911.)—Two very small equal volumes of definite shape placed in a gaseous medium are not in general in the same state: the irregularities of the movements of the molecules and their chances of collision will cause one of these volumes to contain more molecules than the other; there may also be a difference of temperature between the two. These local differences of pressure and temperature seem to play a part in the phenomena of catalysis: they may also intervene in very much the same way, in the absorption of gas by porous bodies, such as carbon. This question is considered in detail, first with respect to a perfect gas, then with reference to CO_2, and the conclusion arrived at is that from these considerations the above explanation of absorption phenomena is not open to any serious objection. A. E. G.

230. *Solubility of Gases in Tantalum and Tungsten.* **A. Sieverts** and **E. Bergner.** (Ber. Deut. Chem. Gesell. 44. pp. 2394–2402, 1911.)—Using the method previously described [Abstract No. 800 (1911)], the solubility of hydrogen in Ta at varying temperatures up to 1330° C. has been measured. Under the same hydrogen pressure the solubility decreases with rise in temperature, and at a given temperature (above 450°) it is proportional to the square root of the pressure. The solubility curve is very similar to that obtained with Pd and hydrogen, and quite different from the curves of Cu, Ni, Fe, Co, and Pt. With Pd and Ta the absorption is an exothermic process, whereas with the other metals it is endothermic. The order of solubility is much the same for Ta and Pd. When heated in hydrogen, Ta-wire undergoes a structural alteration, becoming brittle and crystalline [compare v. Pirani, Abstract No. 2110 (1905)], which properties it retains after the hydrogen has been extracted by heating in a vacuum. Nitrogen reacts slowly with Ta at temperatures above 900°, forming a nitride. The solubility of hydrogen in tungsten is very small at temperatures up to 1500°, and the values obtained were not equilibrium values. Nitrogen does not react with tungsten, even at 1500°. T. S. P.

231. *A Correlation of the Elastic Behaviour of Metals with certain of their Physical Constants.* **J. Johnston.** (Washington Acad. Sci., Journ. I. pp. 260–267, Dec. 4, 1911.)—The author has calculated the effect of pressure acting on the solid phase alone, in lowering the melting-point of metals, from thermodynamical principles, and has computed the pressures required to bring the melting-points of the metals down to 25° C. If the metals are arranged in the order of increasing values of this pressure (denoted by p), the sequence is found to be identical with that obtained by arranging the metals in order of any of their elastic properties. As p increases, the compressibility decreases while the other elastic properties increase. In fact the mechanical properties are related to the amount of pressure requisite to cause the metal to melt at ordinary temperatures, and since this pressure depends on the melting-point, density and heat of fusion, the first two of which are periodic functions of the atomic weight, it would be expected that the elastic properties should be periodic functions too; and this has been shown to be true of the compressibility. Further, the concordance would indicate that the "flow" of metals is due to actual fusion and re-solidification of the crystals. F. C. A. H. L.

232. *Difficulties of Casting Aluminium-Bronze.* **A. L. Brassiere.** (Mech. Eng. 28. p. 712, Dec. 8, 1911. From "The Foundry.")—Gives the results of experiments in the casting of aluminium-bronze in order to avoid formation of dross in the castings by the use of fluxes and the addition of other metals. Boron was tried in the form of anhydrous boracic acid but gave no improvement in the resulting metal. In the casting of aluminium-bronze, moulding is a very important factor. The author does not advise pouring slowly and at a low temperature but meets with better success when pouring strongly from the bottom, keeping the gate choked and placing a long riser on the top of the casting. The best flux is 0·5 per cent. manganese chloride or 1 per cent. of bicarbonate of soda. After the soda has been added and just before the bronze is ready to pour, 0·5 per cent. of a mixture of equal parts of borax and potassium dichromate should be added. Solid copper castings can be made by the use of manganese chloride as a flux. C. O. B.

233. *Shrinkage of Alloys during Solidification.* **D. Ewen** and **T. Turner.** (Inst. of Metals, Journ. 4. pp. 128–158; Discussion and Correspondence, pp. 159–162, 1910. Engineering, 90. pp. 678–683, Nov. 11, 1910.)—Contains an introduction by T. Turner, in which the conditions under which a change of volume may be expected when substances are subjected to changes of temperature are discussed. These are: (1) when chemical union takes place; (2) when allotropic or dimorphic transformations occur; (3) when dissolution and separation from solution occur; (4) when constituents separate during the solidification of a eutectic. D. Ewen gives the results of researches on the shrinkage of the Sb-Pb alloys and the Al-Zn alloys during and after solidification. No expansion was observed in the shrinkage curve of pure Pb, but pure Sb expands to a considerable extent; on making increasing additions of Sb to Pb expansion occurs, and increases to a maximum with about 13 per cent. Sb, the eutectic ratio; it then falls to a minimum at about 35 per cent., whence it rises to a second maximum at about 50 per cent., and after falling again to 60 per cent. it increases gradually up to that of pure Sb. It is found that the amount of expansion on solidification is, unlike the case of the Cu-Zn alloys, not proportional to the range of temperature over which solidification takes place; the unexpected maximum at 50 per cent. Sb is ascribed to some crystalline change. Results of hardness tests carried out by means of Shore's scleroscope are given and also photomicrographs of the alloys. It would appear that in casting alloys containing between 14 and 24 per cent. of Sb, a temperature as low as possible should be used in order to avoid segregation. On examination of the Al-Zn alloys it was first noted that the greatest amount of piping occurred with the pure Zn, pure Al and eutectic (4·81 per cent. Al) bars. The curve of max. expansion for each alloy shows that the expansion on solidification drops from that of pure Zn to a minimum at 2·4 per cent. Al, exhibits a small maximum at the eutectic composition (4·81 per cent.) and then rises uniformly to a second much larger maximum at about 50 per cent. Al, after which it undergoes a sudden fall and finally rises, slowly at first and then more rapidly to a large expansion shown by pure Al. Disregarding the eutectic expansion, the expansions on solidification are approximately proportional to the range of temperature over which solidification takes place for alloys containing from 2 to 50 per cent. aluminium. Hardness and tensile tests are given and also photomicrographs and results of pyrometric observations. In both these series of alloys the expansions take place during solidification, no arrest in the shrinkage curve being noticed after the eutectic halt. C. O. B.

234. *Volume-changes in the Alloys of Copper with Tin.* **J. L. Haughton** and **T. Turner.** (Inst. of Metals, Journ. 6. pp. 192–212; Discussion and Correspondence, pp. 213–221, 1911. Engineering, 92. pp. 609–611, Nov. 3, and pp. 646–648, Nov. 10, 1911.)—This is a continuation of researches on the changes of length which occur in a cast bar during and after solidification [see preceding Abstract]. The apparatus previously described has been modified to allow a single operator to observe both pyrometer and extensometer readings at the same instant. The materials used consisted of pure electrolytic Cu and the purest obtainable tin. The bars examined ranged from pure Cu to pure Sn in steps of 5 per cent., except in a few cases where intermediate alloys were made. On the expansion curve during solidification, four maxima are observed; three of these, at about 10, 46 and 65 per cent. Sn respectively, agree with the "crystallisation interval" as determined from the accepted

equilibrium diagrams. The maximum observed at 80 per cent. Sn is not easy to explain unless it be assumed that the "crystallisation interval" extends down to 500° C. In addition to expansion during solidification, most of the bars show marked changes in the rate of contraction, many of which appear to correspond with phase changes as shown by the equilibrium diagram. The most pronounced change occurs with the Sn-rich alloys at about 220° C. and is caused by separation of the eutectic. Another volume-change of considerable interest occurs at 500° in the alloys containing 15 to 25 per cent. Sn, where $\alpha + \beta$ change into $\alpha + \delta$. Hardness tests were carried out by means of the scleroscope, and a high maximum was found at 80 per cent. Sn, which corresponds to the maximum shown on the expansion curve. The hardness curve obtained does not agree with the theory of Kurnakow and Żemcżużny. It was found impossible to get accurate determinations of the densities of the Cu-rich bars on the original castings, owing to blow-holes. C. O. B.

235. *Cementation (Case-hardening) of Steel.* **F. Giolitti.** (Iron and Steel Inst., Journ. 84. pp. 307–330, 1911. Engineering, 92. pp. 648–651, Nov. 10, 1911. Abstract in Mech. Eng. 28. pp. 448–453, Oct. 13, 1911.)—The author summarises his previous work on the subject [Abstracts Nos. 1360 (1910); 165, 1271 (1911)], from which is clear the advisability of using carburising agents (1) whose activity is, at any rate principally, due to the specific carburising action of CO, (2) whose chemical composition is as simple as possible, absolutely definite, and accurately known, and (3) the reaction between whose constituents and those of the steel are simple and proceed rapidly, under conditions most easily obtaining in practice, to a well-defined state of equilibrium, corresponding to definite concentrations of carbon in the carburised zone. These conditions are well realised by the simultaneous use of free carbon and CO, a "mixed" agent which possesses many technical advantages both as regards quality of product and method of operation. A full description, with illustrations, is given of the type of furnace best adapted for the case-hardening of small and medium-sized objects. It consists of a double-muffle furnace provided with regenerators, the muffles being cylindrical, arranged vertically, and heated by producer gas. The articles to be case-hardened are charged at a temperature of about 800–900° C., the free space in the retort filled with glowing granular carbon, and the mixture heated in a current of CO at a temperature between 900° and 1000° for the requisite time, which depends on the result to be obtained, and is usually from 1 to 2 hours. The productive capacity of each retort ranges from 1 to 5 tons of case-hardened steel per 24 hours. Details are given of the application of the process to an ordinary mild steel, and a chromium-nickel steel, a study of which demonstrates how this process prevents excessive concentration of carbon in the superficial zones, and rapid diminution of the carbon in passing to the deeper layers, which are the principal causes of brittleness and peeling always occurring, in a greater or less degree, in steels case-hardened by the ordinary process. The process is also found suitable for case-hardening those special steels, on the exterior of which the ordinary process yields carburised zones which are practically useless on account of their excessive brittleness. W. H. Si.

236. *Transformations of Steel within the Limits of the Temperatures employed in Heat Treatment.* **L. Grenet.** (Iron and Steel Inst., Journ. 84. pp. 13–53; Discussion and Correspondence, pp. 54–75, 1911. Engineering, 92. pp. 509–511, Oct. 13, and pp. 541–544, Oct. 20, 1911.)—This paper is divided into sections on (I) Allotropic modifications, (II) Transformations of steels, (III) Relations between the mechanical properties and the thermal treatment undergone by a steel, (IV) Classification of steels indicative of the variations in properties in terms of the heat treatment, (V) Nature of the transformations of steels, and (VI) Mode of action of the different elements on the temperature of transformation both on heating and on cooling. The paper is unsuitable for brief abstract, but its scope may be gathered from the conclusions which are as follows: (1) The iron-carbon alloys partake of the general category of alloys and no complications due to allotropic transformation of the element iron need be taken into consideration. (2) It is quite easy to represent by simple diagrams the mode of influence of the special elements on the temperature of transformation on cooling. (3) Quenching may act as follows: (*a*) By changing the nature of the constituents and notably by preventing, wholly or partly, the transformation on cooling. This case is rare, and in the few instances in which such quenchings are known the quenched state is often softer than the annealed state. (*b*) By lowering the temperature of the transformation on cooling. In this, which is the most usual case, the quenched metal is always harder than the annealed metal. (4) The following very general law may be formulated. An alloy is the harder in proportion as the transformation which has given birth to its constituents at the time, has taken place at a lower temperature, has been more rapid, and as the maximum temperature reached since the last transformation has been lower and has been maintained for a shorter period of time. C. O. B.

237. *Temperature Influences on Carbon and Iron.* **E. Adamson.** (Iron and Steel Inst., Journ. 84. pp. 86–99; Discussion and Correspondence, pp. 100–112, 1911. Engineering, 92. pp. 507–509, Oct. 13, 1911.)—Deals with the effect of temperature on the condition of carbon in cast-iron and shows that carbon is precipitated as free carbon virtually, in the absence of Si. In the author's opinion this precipitation, in the case of the manufacture of pig-iron, primarily depends upon the original temperature to which the iron is raised in the blast furnace. The percentage of carbon taken up by iron depends on the temperature and the time it remains at a high temperature. The various conditions in which free carbon may exist in iron are approximately as follows: (1) Very fine graphite liberated at low temperatures and such as is generally found in mottled iron: this appears to be the first stage of free carbon when it is separated as such in a large section of metal. (2) A condition of graphite showing a crystallisation not unlike frost on glass: this can be produced from white iron by annealing for a long period at a high temperature or in hard grey-iron by very slow cooling. (3) Large flake graphite as found in open soft-irons: formed at high temperatures. The facts stated in the paper are of vital importance in the grading of pig-iron. The author has shown on several occasions that it is not possible to regulate tests by Si only, and has no hesitation in saying that the fracture indication is quite as satisfactory as the Si test if the user is fully conversant with fracture indications. C. O. B.

238. *Alloys of Nickel and Zinc.* **E. Vigoroux** and **A. Bourbon.** (Bull. Soc. Chim. 9. pp. 873–879, 1911.)—It has been shown by Tafel that Ni combines with Zn to form $NiZn_3$, and Voss has confirmed Tafel's results. The authors find that there are two alloys, namely, $NiZn_4$ and Ni_3Zn. When the amount of Ni was under 19 per cent. the ingots obtained were homoge-

neous; at 19 per cent. they became brittle, and with much larger amounts of Ni they became more and more malleable. With Ni-contents up to 70·9 per cent. the alloys were non-magnetic, but from 72·8 per cent. upwards they are magnetic. When pulverised and subjected to the action of hydrochloric or acetic acid, the residues from mixtures containing up to 18·8 per cent. of Ni became progressively richer in this element and developed magnetic properties. The residues from mixtures containing over 18·8 per cent. Ni showed little variation in composition as the attack progressed. Alloys containing less than 18 per cent. of Ni on treatment with dilute nitric acid gave invariably a residue containing 18·6 per cent. of Ni, corresponding with the alloy $NiZn_4$, which was isolated in this way as a crystalline, non-magnetic powder of density 7·71 and m.p. 850°. This was rapidly attacked by dilute HCl, leaving a magnetic deposit which was sometimes pyrophoric; the solution generally contained Zn only. Dilute sulphuric acid attacked the alloy slowly, forming a solution of the two sulphates, and depositing a magnetic powder. Nitric acid of more than 1 per cent. strength dissolved the alloy completely. Nickel chloride solution dissolved the alloy on warming, giving rise to zinc hydroxide and a magnetic deposit. The e.m.f.'s developed by the use of electrodes formed of mixtures of the two metals against electrodes of zinc were examined; these showed "breaks" at 18·88 per cent. and 72·92 per cent. of nickel, corresponding with the compounds $NiZn_4$ and Ni_2Zn respectively. L. H. W.

239. *The Decomposition of NO_2 by the Glow Discharge.* **J. Zenneck** and **B. Strasser.** (Phys. Zeitschr. 12. pp. 1201–1204, Dec. 15, 1911.)—A current of N_2O_4 gas, from pure liquid N_2O_4, is passed under pressure of about 1 mm. of Hg at the rate of 8 m./sec. through a U-tube, the electrodes of which are at the top of the limbs. Four glow-light columns—(i) yellow-orange, (ii) violet-blue, (iii) green-yellow, (iv) light red—can thus be distinguished, and beyond them a dull yellow afterglow. The relative dimensions of these columns change with the rate of flow and the current intensity. When the discharge is produced in a wide cylindrical tube the four colours appear one after the other. The spectra of the four columns seem to be: (i) N_2O_4 or NO_2; (ii) some intermediate oxide N_2O_3 (?); (iii) NO; (iv) N with faint O lines. The afterglow seems to be produced chiefly by (i) and (iii), not by (ii), and not strongly by (iv). The spectrum of its afterglow is continuous, and shows in the ultra-violet the heads of the bands of N. These afterglow observations were conducted in three ways, also by watching the discharge at the moment when it passed through zero, with the aid of a slitted disc fixed on the shaft of synchronous motor. There is no reference to R. J. Strutt. H. B.

240. *Small Electric Furnace with Heating Element of Ductile Tungsten or Molybdenum.* **R. Winne** and **C. Dantsizen.** (Amer. Electrochem. Soc., Trans. 20. pp. 287–290; Discussion, pp. 290–292, 1911.)—Constructional details are given of a crucible furnace and a tube furnace. The former can be run up to 1700 C. with safety, at which temperature it takes 45 amps. at 25 volts. With the tube furnace a temperature of 1600° C. can be attained, the power consumption being then 14·8 amps. at 80 volts. A protective atmosphere of hydrogen is used. L. H. W.

241. *The Passive State of Metals.* **F. Flade.** (Zeitschr. Phys. Chem. 76. pp. 513–559, 1911.)—The author has investigated the behaviour of electrodes of Fe, Co, and Ni in the passive state. On connecting such a passive electrode in circuit, the current at first is of considerable magnitude, but falls rapidly, and finally reaches a minimum value. The behaviour is not reproducible; the time taken to reach the minimum current, the magnitude of the minimum current, and other factors differ considerably under apparently similar conditions. If the polarisation potential of a passive electrode in the stationary state is altered by altering the resistance in the circuit, Ni and Cr show normal behaviour, inasmuch as the current increases with diminished resistance and consequent increase of polarisation potential. In the case of Fe, however, the current is, within fairly wide limits, independent of the potential. With rise of temperature the potential of a stationary passive electrode diminishes; the current increases. The temperature coefficient varies in different experiments. The change from the passive to the active modification when the circuit is broken proceeds in the case of dilute sulphuric acid as follows: In the case of Fe, the potential falls rapidly at first, and then the fall becomes slower with considerable variations of potential. In the case of Ni the rate of fall in potential is much more regular. With Fe there is a definite potential, largely independent of the experimental conditions, at which the Fe suddenly becomes active; the potential is independent of the presence of ferrous and ferric ions, but depends on the acid concentration. The formation of layers of oxide of varying composition appears the most plausible explanation of the passive state. L. H. W.

242. *Colour and Size of Particles of Colloidal Gold Solutions.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 1565–1570, Nov., 1910.)—The author has centrifugalised various colloidal gold solutions of different colours and investigated the absorption of the solutions from time to time by means of a spectral photometer. The transparency of the solutions towards red increases in much greater proportion than the transparency towards blue, during the time the solutions are centrifugalised. Since the process of centrifugalisation brings about the deposition of the larger particles, it follows that in red colloidal gold solutions the particles are much smaller than in blue solutions. [See Abstract No. 589 (1910).] T. S. P.

243. *Electrolysis of Sodium Chloride with the Mercury Kathode.* **C. A. Peters.** (Amer. Journ. Sci. 32. pp. 365–385, Nov., 1911.)—The author shows that in the electrolysis of sodium chloride in the Hildebrand apparatus for the electrolytic determination of anions, the anode being of silver or of silver-plated Pt and the kathode of mercury, silver is always transferred from the anode to the kathode. Under certain conditions, which must be determined by experiment for each apparatus and strength of solution used, the amount of silver thus transferred may be neglected for analytical purposes. It is recommended that the anode covered with silver chloride be first heated below the fusing point of the chloride to decompose all the silver oxide, and that then the heat be increased so as to fuse the chloride, 5 or 10 min. at 400–500° being sufficient. Sodium hydroxide is always present in the inner cell after the beginning of the electrolysis, a low current with corresponding increase in time of electrolysis producing more alkali than a high current and short time of electrolysis. The best method for removing the fused chloride from an anode is to heat it for about 20 min. at 500° in a current of hydrogen. [See Abstract No. 480 (1910).] T. S. P.

244. *Studies of Ammonium Solutions.* I. *An Ammonium Electrode.* **R. E. Slade.** (Chem. Soc., Journ. 99. pp. 1974–1982, Nov., 1911.)—The potential of the ammonium electrode at 25° has been determined, and has been shown to depend upon the partial pressures of hydrogen and ammonia, and on the concentration of the ammonium ions in the following way :—

$$e = -0{\cdot}486 - 0{\cdot}059 \log \left(p_{NH_3}\, p_{H_2}^{1/2} / [NH_4^{\cdot}]\right),$$

where $e = e_{\text{electrode}} - e_{\text{solution}}$, and the potential of the hydrogen electrode in a solution of normal hydrogen-ion concentration is taken as zero. The electrode consisted of platinised Pt dipping into a solution of ammonium chloride and ammonia, through which a stream of electrolytic hydrogen passed, after bubbling through a solution of ammonia of the same strength as that in the solution of ammonium chloride. Theory shows that the potential measured is that of the chemical reaction : $2NH_3 + H_2 \longrightarrow 2NH_4^{\cdot}$, no matter whether the electrode reaction be supposed to be : $NH_4 \longrightarrow NH_4^{\cdot} + \ominus$ or $H \longrightarrow H^{\cdot} + \ominus$. The steadiness of the electrode suggests that the former is probably the electrode reaction, since the hydrogen electrode does not give as good results, being particularly untrustworthy in dilute alkaline solutions. Complexes of the form $(NH_3)_x H^{\cdot}$, where x is greater than one, do not exist to any appreciable extent in dilute aqueous ammonia or ammoniacal ammonium chloride solutions, although there is some evidence of their existence at higher concentrations. T. S. P.

245. *Separation of Radio-active Decay-products.* **L. Meitner.** (Phys. Zeitschr. 12. pp. 1094–1099, Dec. 1, 1911.)—A simple electrolytic method is given whereby various decay-products may be obtained from solutions. The decay-product obtained seems to depend on the metal used as the kathode, RaB and C, for example, being obtained much better using a silver kathode than with a kathode of Ni, Au, or Pt. [See also Abstracts Nos. 1884 (1907) and 2066 (1909).] A. W.

246. *Physical and Chemical Laws.* **G. Jaumann.** (Akad. Wiss. Wien, Sitz. Ber. 120. 2a. pp. 385–530, April, 1911.)—A dissertation dealing with a closed system of physical and chemical differential laws or equations, and covering a very large field in physics and chemical physics. [See Abstract No. 1698 (1908).] E. H. B.

247. *Effect of Salts on the Solubility of other Salts.* IV. *Solubility of Uni-univalent Salts in the Presence of other Salts.* **W. C. Bray.** (Amer. Chem. Soc., Journ. 33. pp. 1673–1686, Nov., 1911.)

248. *Fundamental Properties of the Elements.* **T. W. Richards.** (Chem. Soc., Journ. 99. pp. 1201–1218, June, 1911. Faraday Lecture. Abstracts in Nature, 87. pp. 29–32, July 6, 1911. Electrician, 67. pp. 811–813, Sept. 1, 1911.)

249. *Solubility of Cuprous Oxide in Aqueous Ammonia Solutions, and Composition of the Cuprous-Ammonia Complex.* **F. G. Donnan** and **J. S. Thomas.** (Chem. Soc., Journ. 99. pp. 1788–1796, Oct., 1911.)

250. *Some Remarkable Steel Crystals, with Notes on the Crystalline Structure of Steel.* **E. F. Lange.** (Manchester Lit. and Phil. Soc., Mem. 55. 24. pp. 1–15, 1910–1911.)—The composition and structure of some pine-tree-shaped crystals, up to 15 in. in length, discovered in the pipe in a large riser of a steel casting are described and illustrated. F. C. A. H. L.